NACA RM SE50J11

RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

PRELIMINARY PERFORMANCE DATA ON WESTINGHOUSE ELECTRONIC POWER REGULATOR OPERATING ON J34-WE-32 TURBOJET ENGINE IN ALTITUDE WIND TUNNEL

By James R. Ketchum, Darnold Blivas, and George J. Pack

Lewis Flight Propulsion Laboratory
Cleveland, Ohio

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON
OCTOBER 27 1950

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INTRODUCTION

The behavior of the Westinghouse electronic power regulator operating on a J34-WE-32 turbojet engine was investigated in the NACA Lewis altitude wind tunnel at the request of the Bureau of Aeronautics, Department of the Navy. The object of the program was to determine the steady-state stability and transient characteristics of the engine under control at various altitudes and ram pressure ratios, without afterburning. Recordings of the response of the following parameters to step changes in power lever position throughout the available operating range of the engine were obtained: ram pressure ratio, compressor-discharge pressure, exhaust-nozzle area, engine speed, turbine-outlet temperature, fuel-valve position, jet thrust, air flow, turbine-discharge pressure, fuel flow, throttle position, and boost-pump pressure.

Representative preliminary data showing the actual time response of these variables are presented. These data are presented in the form of reproductions of oscillographic traces.

APPARATUS

Engine. - J34-WE-32 turbojet engine with variable-area exhaust nozzle and WEC-1 afterburner

Minimum fuel flow set to 550 pounds per hour at a windmilling speed of 1500 rpm and an altitude of 2000 feet

Control. - Westinghouse electronic power regulator (part no. 61-F-758-4; serial no. S-CZA-78, modified to correspond to part no. 61-F-758-6 insofar as temperature schedule is concerned)

The original thermocouple harness of nine paralleled short thermocouples was removed and replaced by another group of nine paralleled elements which were emersed 6 inches. The couples were also of equal resistance to insure a more nearly correct average temperature indication.

Test facilities. - Lewis altitude wind tunnel with 20-foot-diameter test section

Air supplied through a ram pipe connected directly to the engine

Instrumentation. - Transient responses of engine variables were recorded on multiple channel, direct-inking, magnetic-motor oscillographs. The recording unit in combination with its amplifier has flat frequency response to approximately 100 cycles per second. The oscillograph chart speed was 2.5 units per second. The following table lists the sensing devices used for indicating variations in the parameters:

Measured quantity	Transient instrumentation		Steady-state instrumentation
	Sensor	Frequency response range (cycles/sec)	
Engine speed	Direct-current tachometer generator	0-5	Chronometric tachometer
Compressor-discharge pressure	Aneroid-type pressure sensor with strain-gage element	0-10 at sea-level pressure	Bourdon-type gage
Turbine-discharge pressure	Aneroid-type pressure sensor with strain-gage element	0-10 at sea-level pressure	Bourdon-type gage
Ram pressure ratio	Aneroid-type pressure sensor with strain-gage element	0-10 at sea-level pressure	Airspeed indicator
Boost-pump pressure	Aneroid-type pressure sensor with strain-gage element	Indeterminent	Bourdon-type gage
Fuel flow (pressure drop across fuel nozzles)	Aneroid-type pressure sensor with strain-gage element	Indeterminent	Rotameter
Air flow (velocity pressure in ram pipe)	Aneroid-type pressure sensor with strain-gage element	0-10 at sea-level pressure	
Turbine-outlet temperature	Unshielded loop thermocouples (five in series)	0-1 at sea-level mass flow	Nine thermocouples in parallel connected to Brown recorder (Westinghouse control thermocouple harness)
Fuel-valve position	Fuel-valve feedback potentiometer connected to give position indication.	0-100	Microammeter attached to fuel valve feedback potentiometer
Exhaust-nozzle area	Exhaust-nozzle-area feedback potentiometer connected to give position indication	0-100	Microammeter attached to exhaust-nozzle-area feedback potentiometer
Throttle position	Wire-wound potentiometer connected to give position indication	0-100	Selsyn indicator
Thrust	Strain gage mounted on strain link attached to forward engine suspension	0-100	

PROCEDURE

Accelerations and decelerations, in the non-afterburning region, were produced by manually advancing or cutting back the throttle in a stepwise manner. Oscillograms of the transients were taken. In addition, steady-state readings, before and after each transient, were recorded on both steady-state and transient instrumentation. Various size steps were made throughout the operating range of the engine at the following flight conditions:

Simulated altitude (ft)	Nominal inlet temperature (°F)	Nominal ram pressure ratio
10,000	48	1.20
25,000	-14	1.05
25,000	-10	1.20
25,000	8	1.60
35,000	-15	1.20
40,000	-10	1.20
45,000	-10	1.20

PRESENTATION OF DATA

The preliminary data presented are in the form of reproductions of oscillograms, which have been reduced to 71 percent of their original size. The data are representative of the operation of the controlled engine over its range of operation.

For all runs the following parameters are shown:

Ram pressure ratio
Compressor-discharge pressure
Exhaust-nozzle area
Engine speed
Turbine-outlet temperature
Fuel-valve position

For some of the runs the following additional parameters are shown:

Jet thrust
Air flow
Turbine-discharge pressure
Fuel flow
Throttle position
Boost-pump pressure

The average steady-state value for the preceding parameters are indicated for calibration purposes on the individual oscillograms, except for the jet-thrust and air-flow records. These traces are shown only to indicate this variation during a transient. Because of the techniques employed in measuring jet thrust, variations in ram pressure influence the thrust trace. This effect of ram variation on thrust can be observed by noting the thrust trace when the ram varies.

As an aid in the understanding and interpretation of the transient runs, a nominal power control lever schedule for static sea-level operation is presented in figure 1(a). This figure shows the temperatures and speeds scheduled for each throttle position. A calibration of nozzle area to its panel reading is presented in figure 1(b).

The oscillograms of the transient data are presented in figures 2 to 63 and are indexed in table I according to altitude, nominal ram pressure ratio, throttle position, engine speed, and turbine-outlet temperature. The figures chosen are representative of the operation of the controlled engine throughout the range of throttle settings.

Lewis Flight Propulsion Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, October 10, 1950.

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TABLE I - INDEX TO TRANSIENT RUNS

Figure	Altitude (ft)	Nominal ram pressure ratio	Throttle position (deg)		Engine speed (rpm)		Turbine outlet temperature, °F	
			Initial	Final	Initial	Final	Initial	Final
2(a)	10,000	1.2	22	30	5,210	5,780	365	405
2(b)			30	22	5,780	5,210	405	365
3(a)			22.5	29.5	5,490	5,640	440	430
3(b)			29.5	22.5	5,640	5,490	440	430
4(a)			35.0	35.5	7,840	8,000	445	450
4(b)			35.5	35.0	8,000	7,840	450	445
5(a)			43.5	49.0	10,900	11,150	460	475
5(b)			49.0	43.5	11,150	10,900	475	460
6(a)			51	62	11,360	11,930	480	515
6(b)			62	51	11,930	11,360	515	480
7(a)			65	70.5	12,230	12,570	580	810
7(b)			70.5	65	12,570	12,230	810	580
8(a)			65	84	12,280	12,500	610	1,215
8(b)			84	65	12,500	12,280	1,215	610
9(a)			22	35	5,150	7,620	380	450
9(b)			35	22	7,620	5,150	450	380
10			42	22	9,950	5,410	450	400
11(a)			22	49	5,420	11,180	380	480
11(b)			49	22	11,180	5,420	480	480
12(a)			22	65	5,410	12,420	405	690
12(b)			65	22	12,420	5,410	690	570
13(a)			22	84	5,420	12,580	415	1,210
13(b)			84	22	12,580	5,420	1,210	430
14(a)	25,000	1.05	22	35	6,750	7,590	725	550
14(b)			35	22	7,590	6,840	550	725
15(a)			36.5	37.5	7,930	8,320	520	520
15(b)			37.5	36.5	8,320	7,930	520	520
16(a)			41.5	43	9,970	10,450	460	---
16(b)			43	41.5	10,450	9,970	470	---
17			42.5	54	10,730	11,400	480	505
18			62	70	11,940	12,520	550	690
19(a)			62	83	12,520	12,680	560	1,190
19(b)			83	62	12,680	12,520	1,190	560
20			22	42	6,890	9,980	710	490
21			22	52	7,100	11,020	700	510
22			22.5	70	7,140	12,520	720	675
23(a)			22	85	6,960	12,690	740	1,190
23(b)			85	22	12,690	7,050	1,190	740

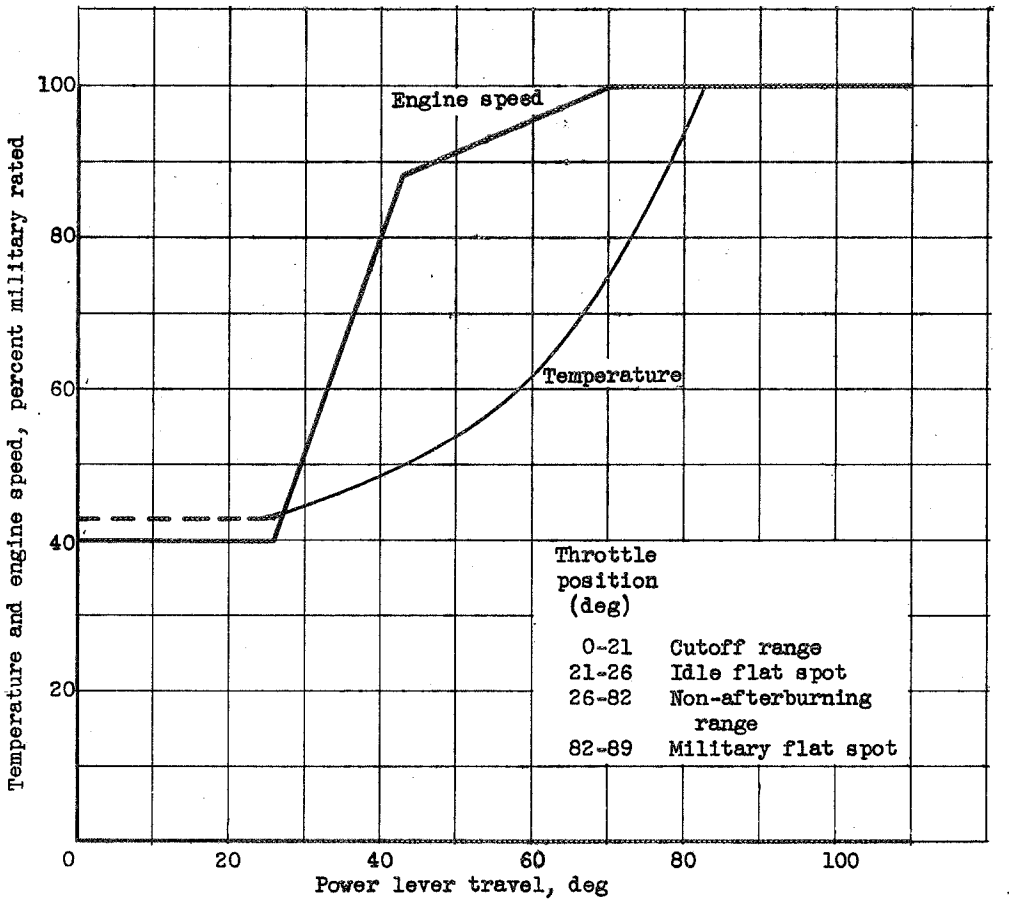
TABLE I - INDEX TO TRANSIENT RUNS - Continued

Figure	Altitude (ft)	Nominal ram pressure ratio	Throttle position (deg)		Engine speed (rpm)		Turbine outlet temperature, °F	
			Initial	Final	Initial	Final	Initial	Final
24	25,000	1.2	22	42	6,820	10,000	540	cali-bration
25(a)			26	72	6,900	12,500	490	770
25(b)			72	26	12,500	6,900	770	490
26(a)			31.5	33.5	6,700	cali-bration	540	cali-bration
26(b)			33.5	31.5	7,140	6,700	435	540
27(a)			34	37	7,810	8,290	390	cali-bration
27(b)			37	34	8,290	7,810	380	cali-bration
28			35	35.5	7,370	7,540	425	405
29(a)			35	85	8,310	12,560	475	1,172
29(b)			85	35	12,560	6,570	1,172	475
30(a)			41	85	10,000	12,540	375	1,215
30(b)			85	41	12,540	10,000	1,215	375
31			43.5	44	10,580	10,910	400	430
32(a)			43.5	55	10,950	11,460	405	445
32(b)			55	43.5	11,460	10,950	445	calib.
33			55	85	11,510	12,540	435	1,215
34			70	85	12,540	12,550	780	1,210
35(a)			20.5	35	6,340	7,360	505	425
35(b)			35	20.5	7,360	6,340	425	505
36(a)			20.5	83	7,280	12,520	600	1,180
36(b)			83	20.5	12,520	7,280	1,180	600
37(a)	25,000	1.6	21	36.5	7,500	8,750	370	340
37(b)			36.5	21	8,790	7,500	340	370
38(a)			33	41	7,760	9,630	410	305
38(b)			41	33	9,630	7,760	305	410
39(a)			33	62	7,900	11,940	415	460
39(b)			62	33	11,940	7,900	460	415
40(a)			40	41	9,600	10,030	280	300
40(b)			41	40	10,030	9,600	300	280
41(a)			62	71	12,000	12,960	465	800
41(b)			71	62	12,960	12,000	800	465
42(a)			70	84	12,570	cali-bration	805	1,220
42(b)			84	70	12,600		1,220	805
43(a)			34	84	8,380	12,580	440	1,220
43(b)			84	34	12,580	8,380	1,220	440

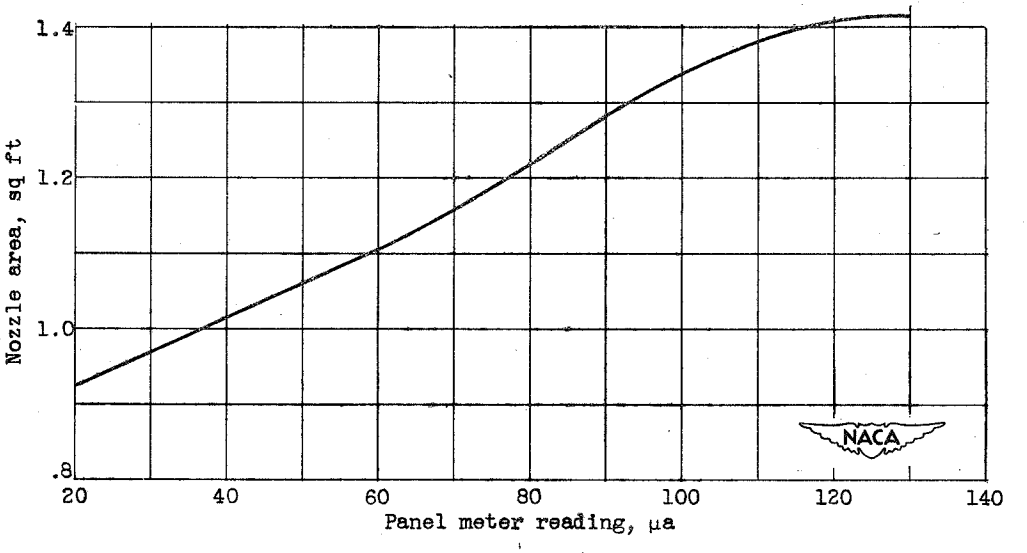
TABLE I - INDEX TO TRANSIENT RUNS - Concluded

Figure	Altitude (ft)	Nominal ram pressure ratio	Throttle position (deg)		Engine speed (rpm)		Turbine outlet temperature, °F	
			Initial	Final	Initial	Final	Initial	Final
44(a)	35,000	1.2	37	40	9,220	10,000	720	570
44(b)			40	37	10,000	9,220	570	720
45			41.5	44.5	10,790	11,100	calibration	440
46(a)			46.5	64.5	11,140	12,000	450	500
46(b)			64.5	46.5	12,000	11,140	500	450
47(a)			60.5	64	11,850	12,100	480	510
47(b)			64	60.5	12,100	11,850	510	480
48			61	70	11,860	12,400	500	685
49(a)			61	84	11,860	12,550	500	1,210
49(b)			84	61	12,550	11,860	1,210	500
50(a)			47	84	11,240	12,580	485	1,220
50(b)			84	47	12,580	11,650	1,220	485
51(a)			36.5	84	9,430	12,560	780	1,210
51(b)			84	36.5	12,560	9,430	1,210	780
52			84	29	12,690	9,260	1,150	840
53	40,000	1.2	42	43.5	11,580	11,160	670	
54(a)			42	50.5	11,420	11,900	650	700
54(b)			50.5	42	11,900	11,420	700	650
55(a)			46.5	55	11,620	11,940	770	calibration
55(b)			55	46.5	11,940	11,620	820	
56(a)			47	66	11,670	12,490	800	calibration
56(b)			66	47	12,490	11,670	840	
57(a)			50	62	11,940	12,430	710	760
57(b)			62	50	12,430	11,940	760	710
58			84	47	12,530	11,660	1,205	810
59			41	84	11,090	12,620	660	1,220
60			84	39	12,620	10,560	1,220	735
61	45,000	1.2	47	47	11,400	calibration	1,260	1,260
62	45,000[a]		80	80	12,500		1,135	1,135
63	45,000[a]		80	84	12,500	12,600	1,135	1,135

[a]Engine-inlet temperature, +47° F.

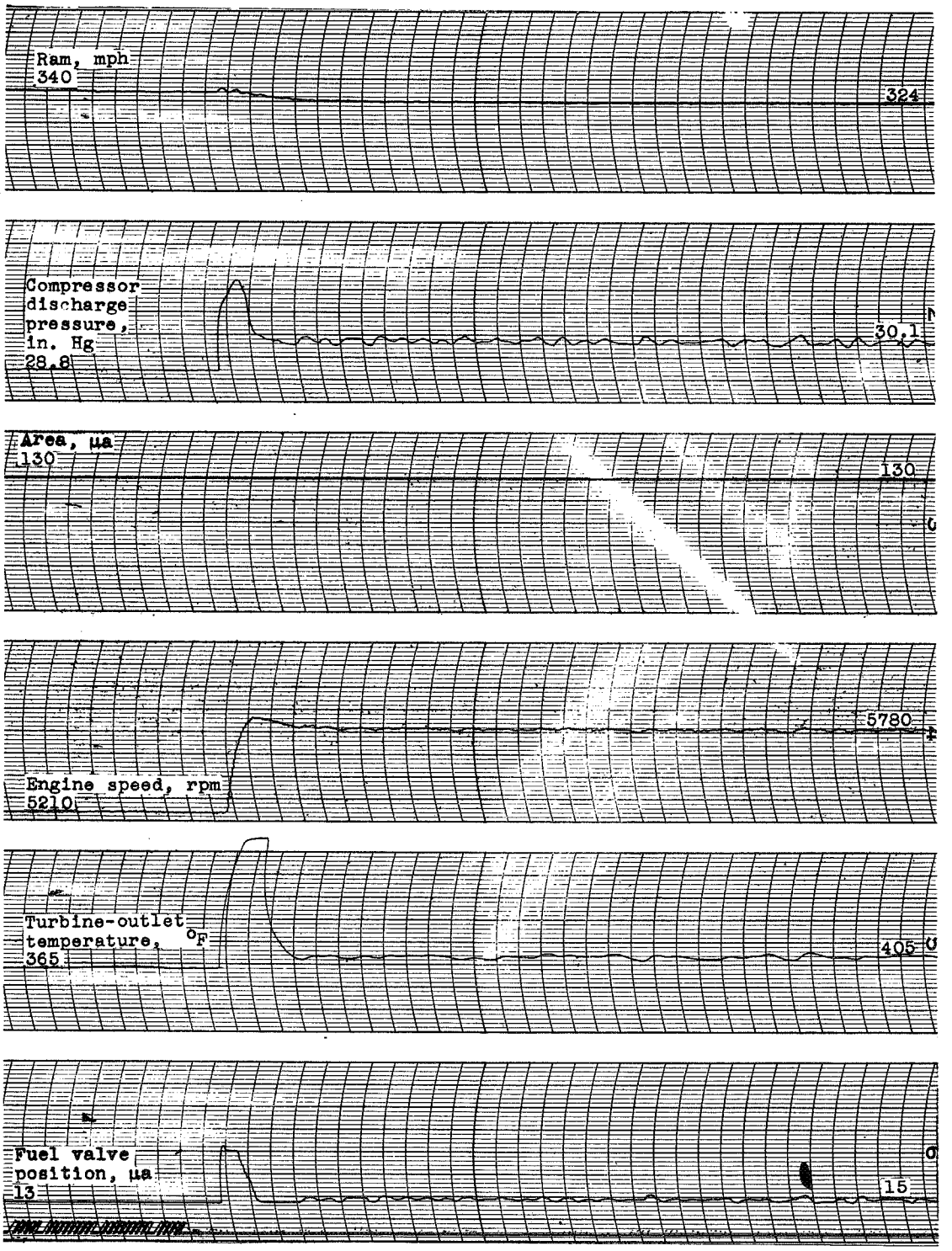


(a) Power control lever schedule for static sea-level operation.



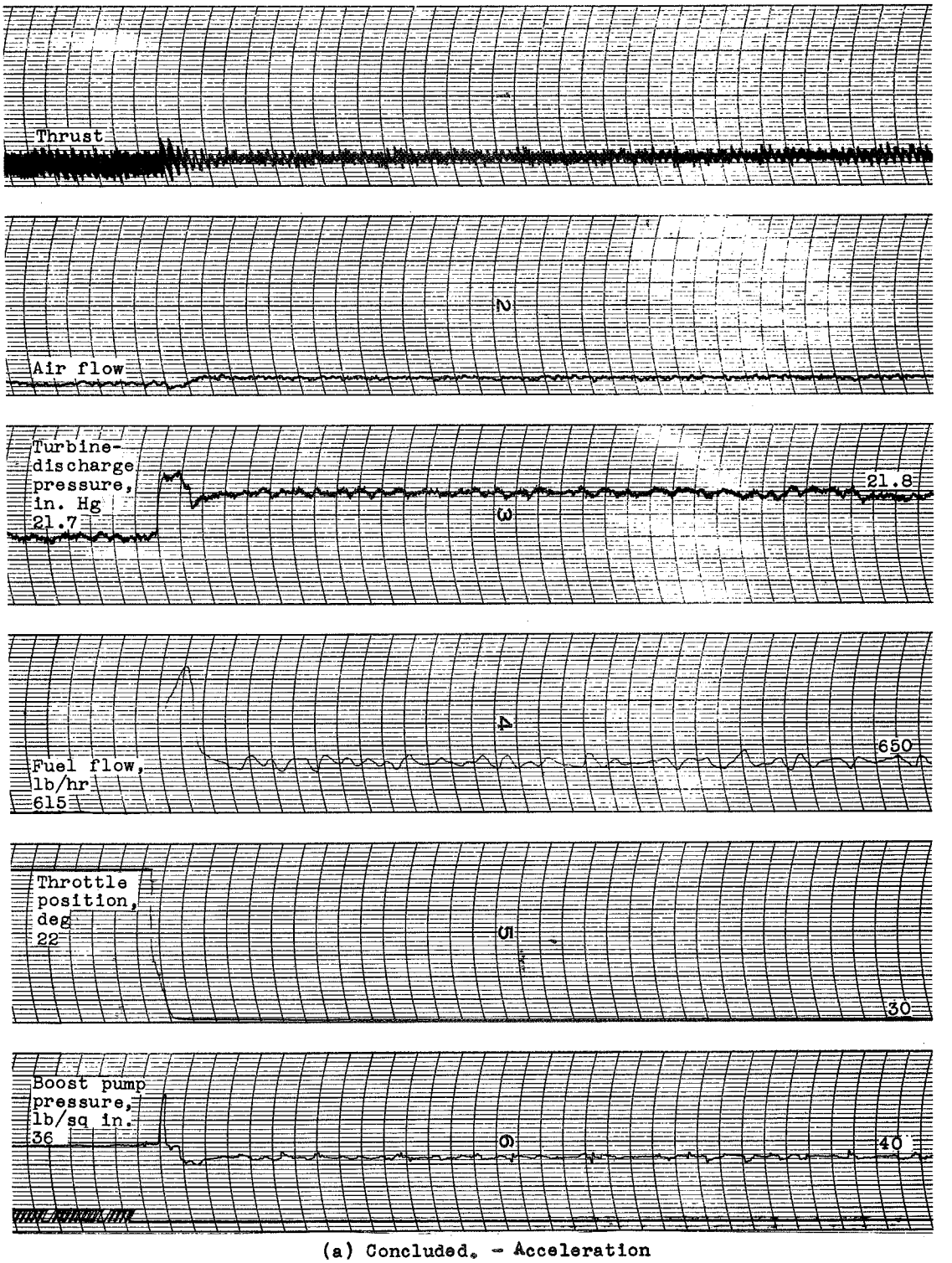
(b) Area indicator.

Figure 1. - Power lever and area indicator calibration curves.



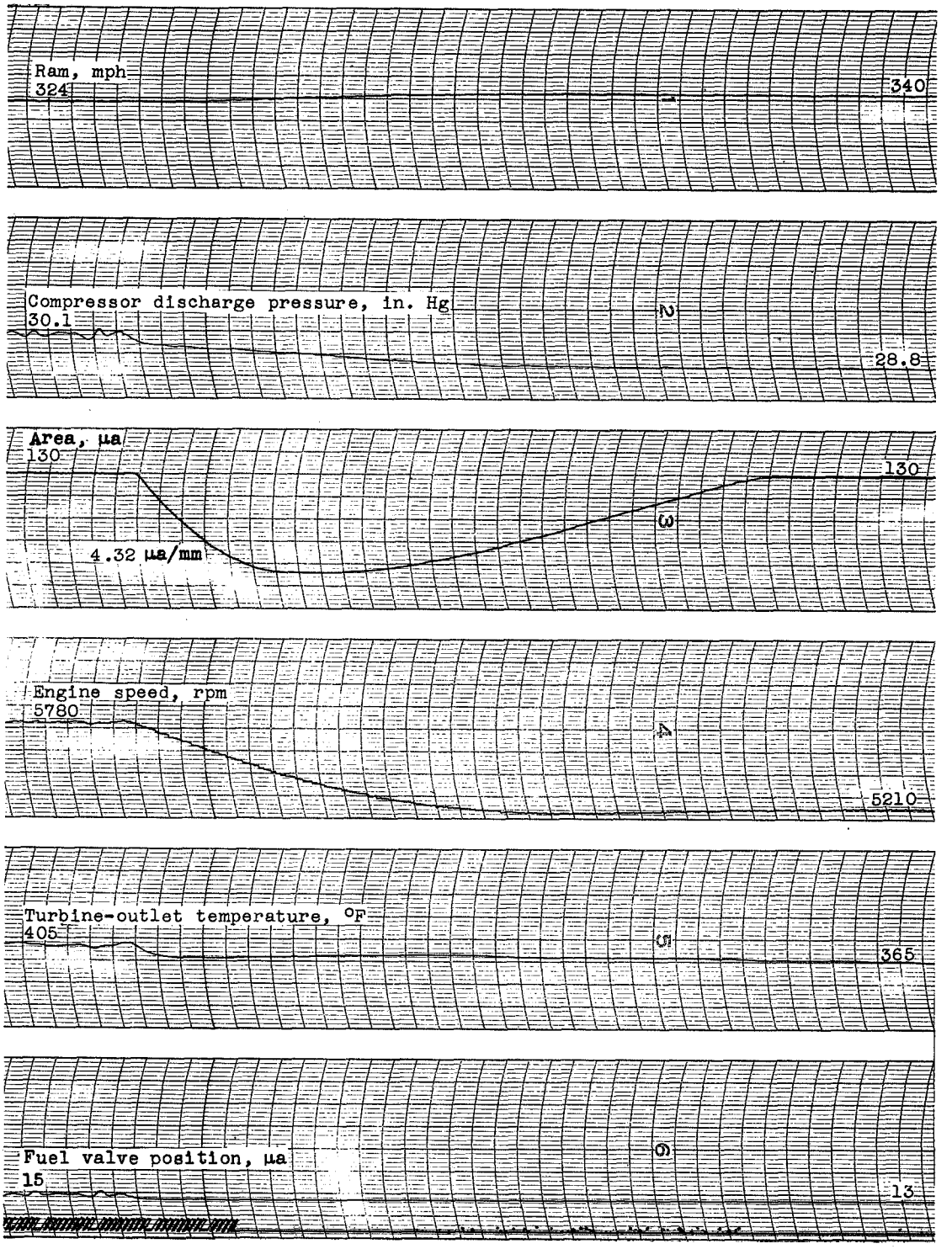
(a) Acceleration.

Figure 2. - Transient operation of automatically-controlled engine. Throttle position, 22° to 30°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



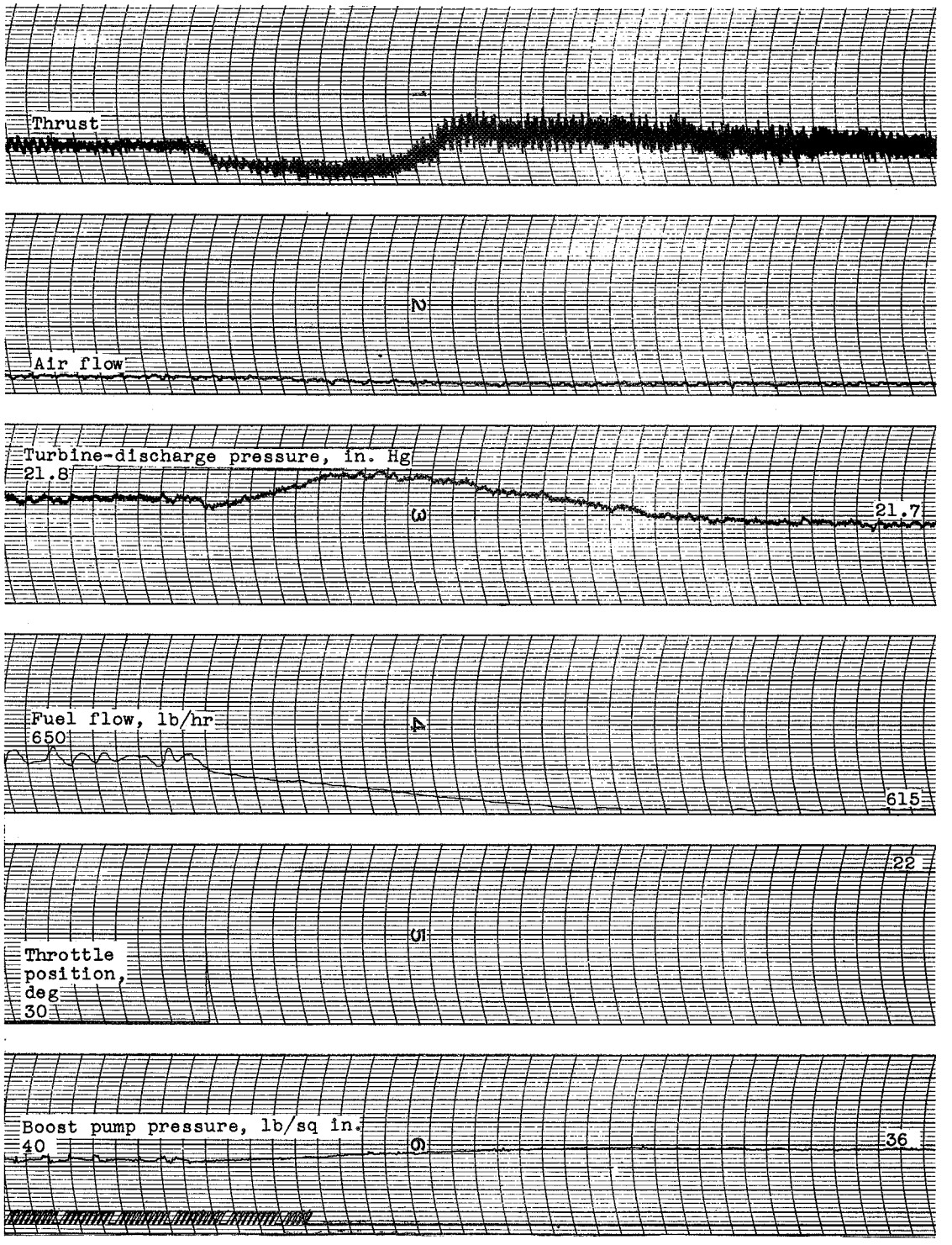
(a) Concluded. - Acceleration

Figure 2. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 30°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



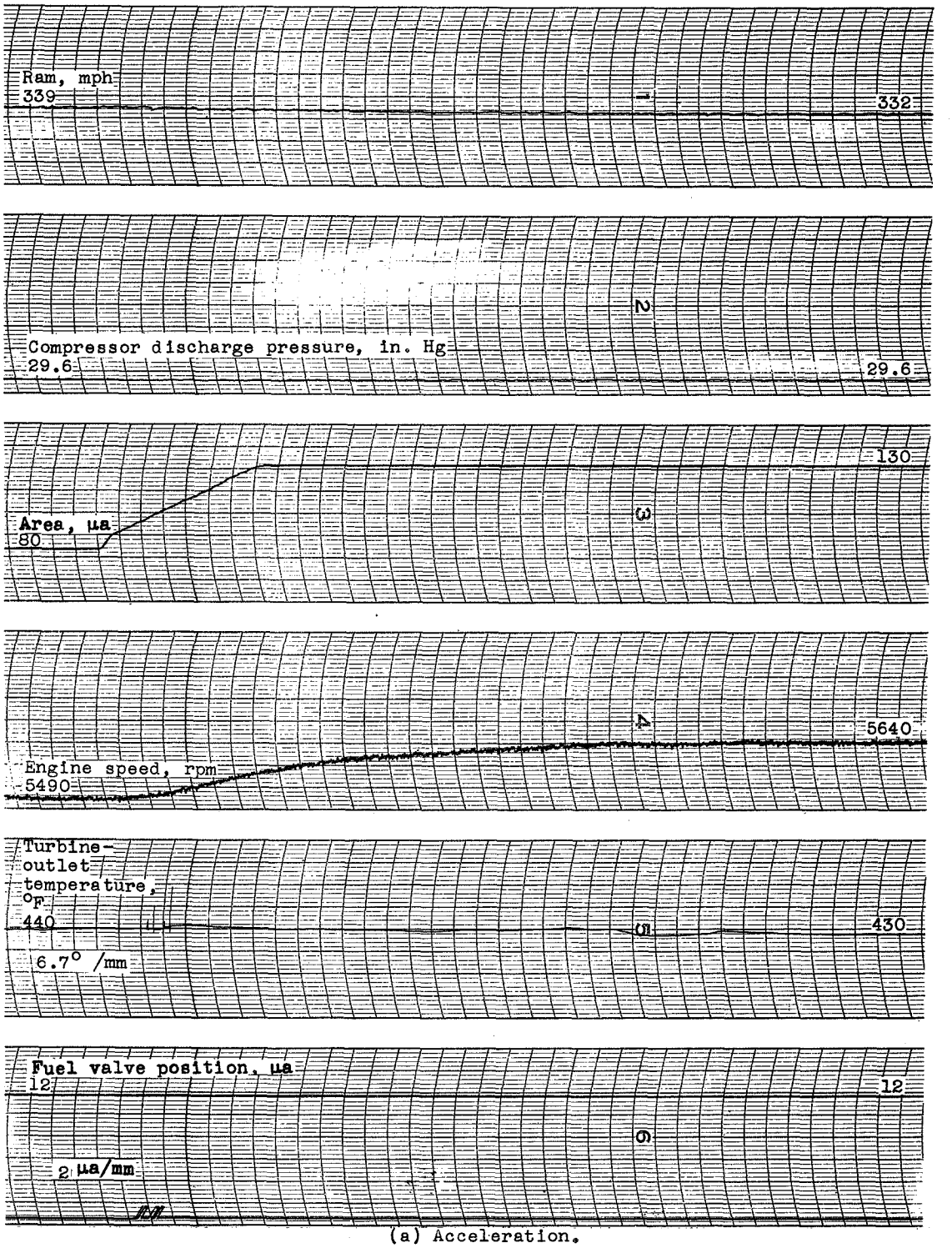
(b) Deceleration.

Figure 2. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 30°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



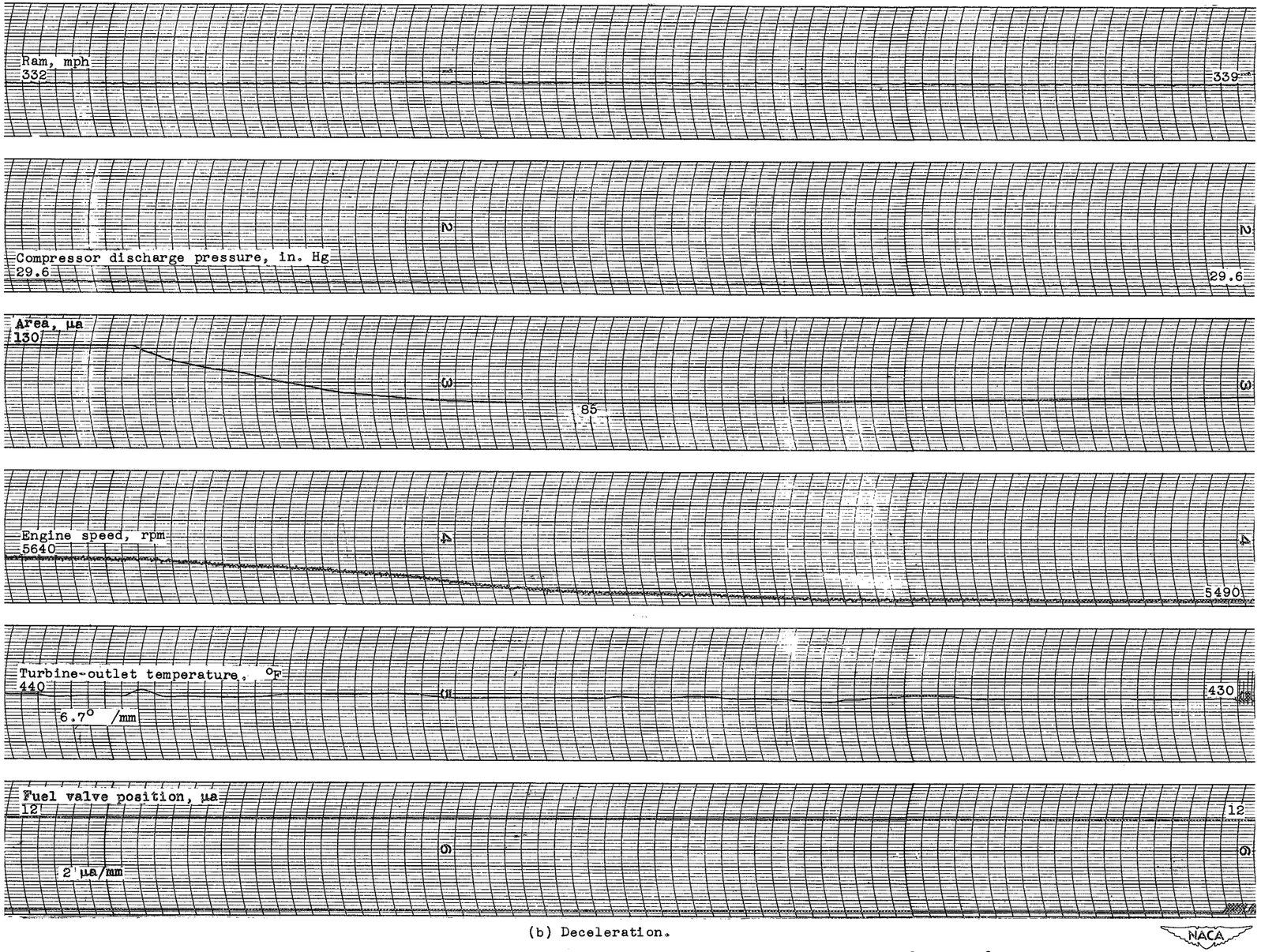
(b) Concluded. - Deceleration.

Figure 2. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22° to 30°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



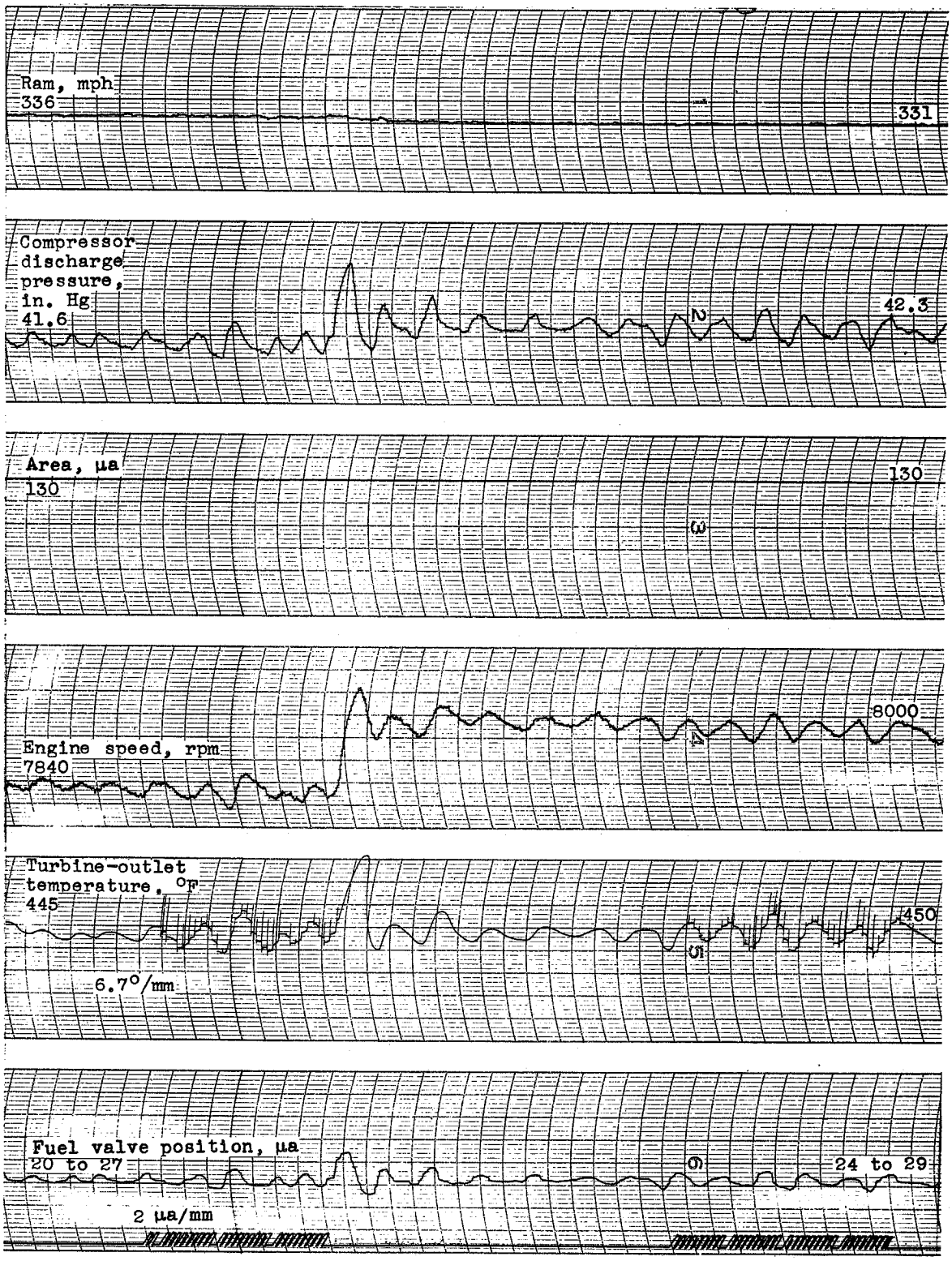
(a) Acceleration.

Figure 3. - Transient operation of automatically-controlled engine. Throttle position, 22.5° to 29.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



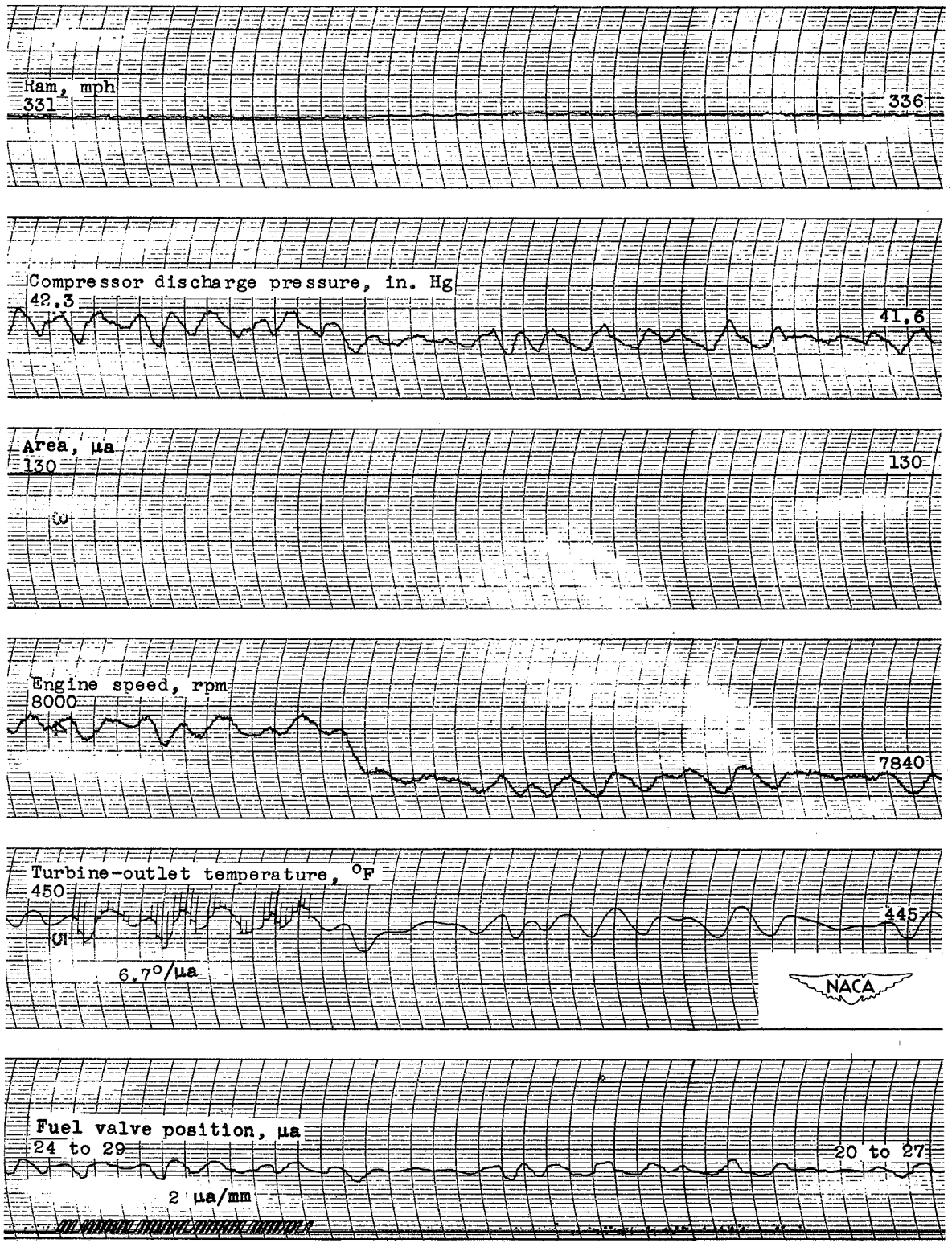
(b) Deceleration.

Figure 3. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22.5° to 29.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



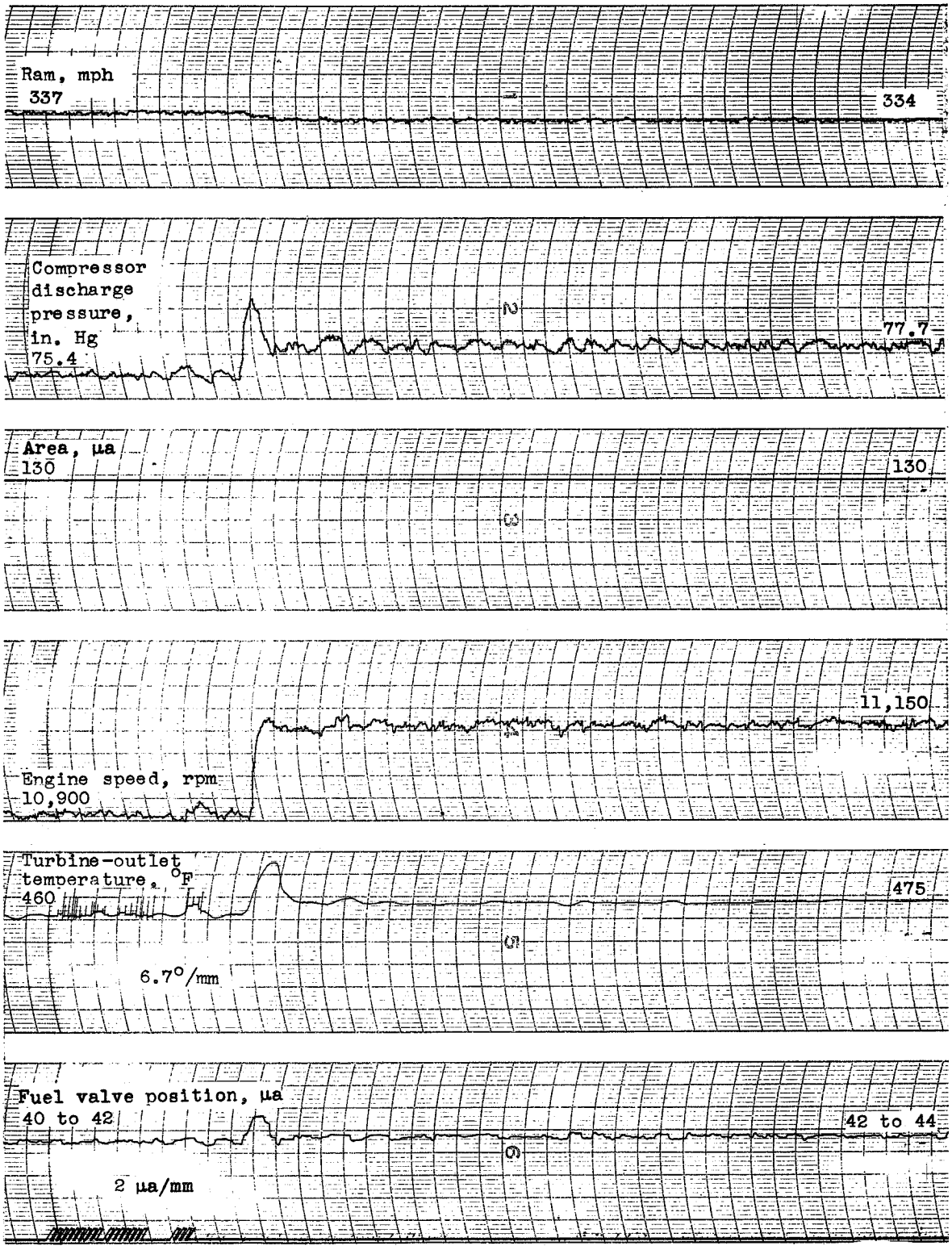
(a) Acceleration.

Figure 4. - Transient operation of automatically-controlled engine. Throttle position, 35.0° to 35.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



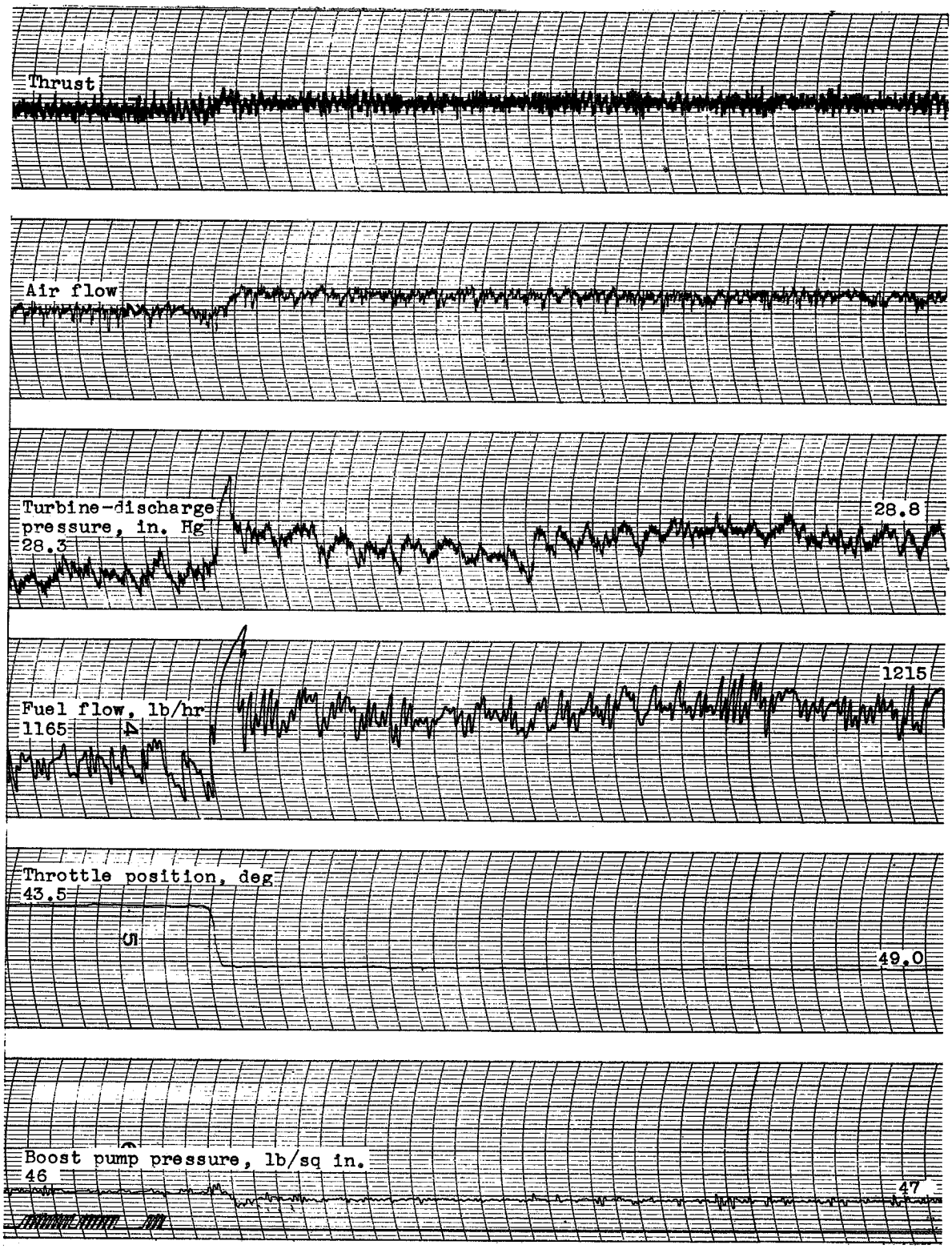
(b) Deceleration.

Figure 4. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 35.0° to 35.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



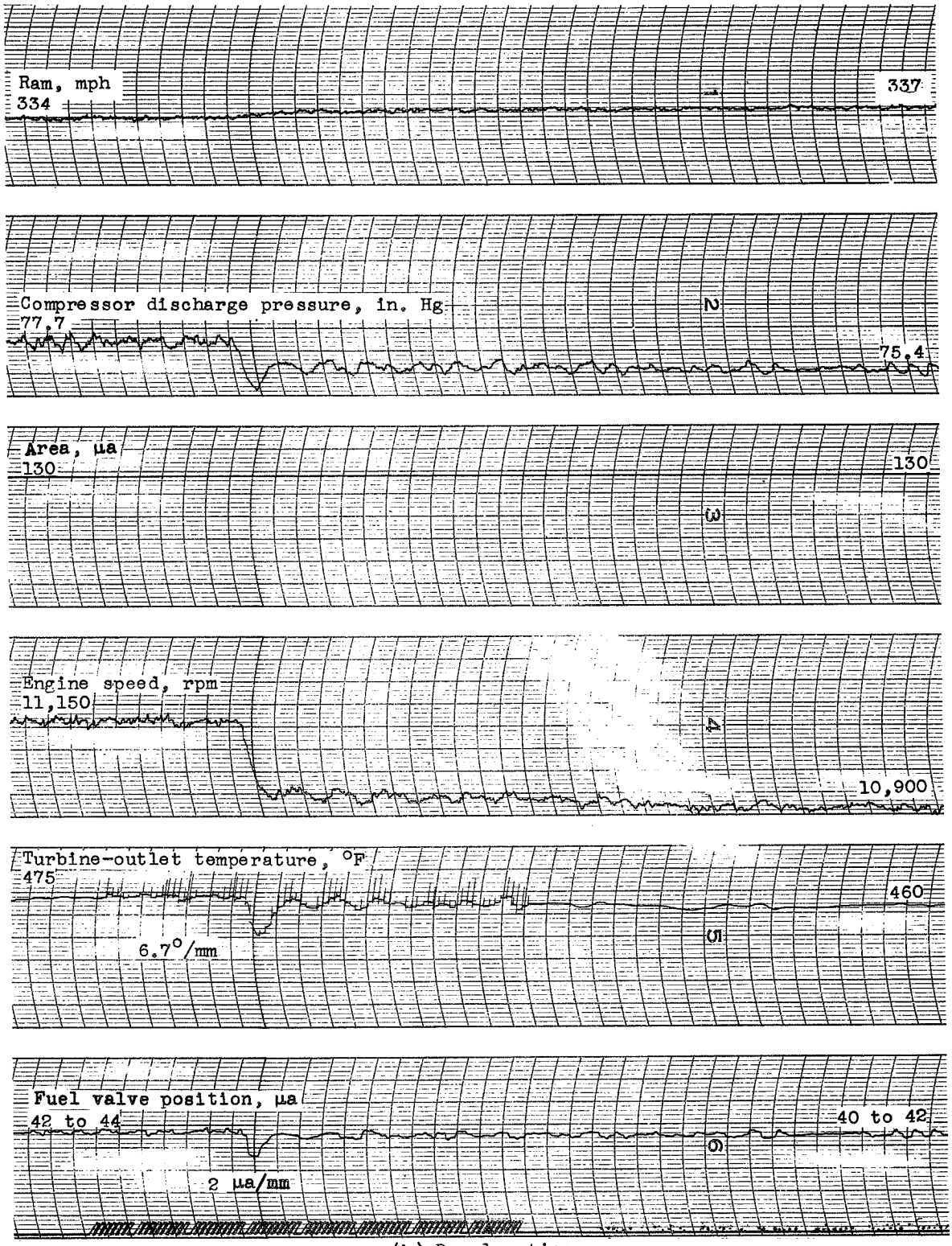
(a) Acceleration.

Figure 5. - Transient operation of automatically-controlled engine. Throttle position, 43.5° to 49.0°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



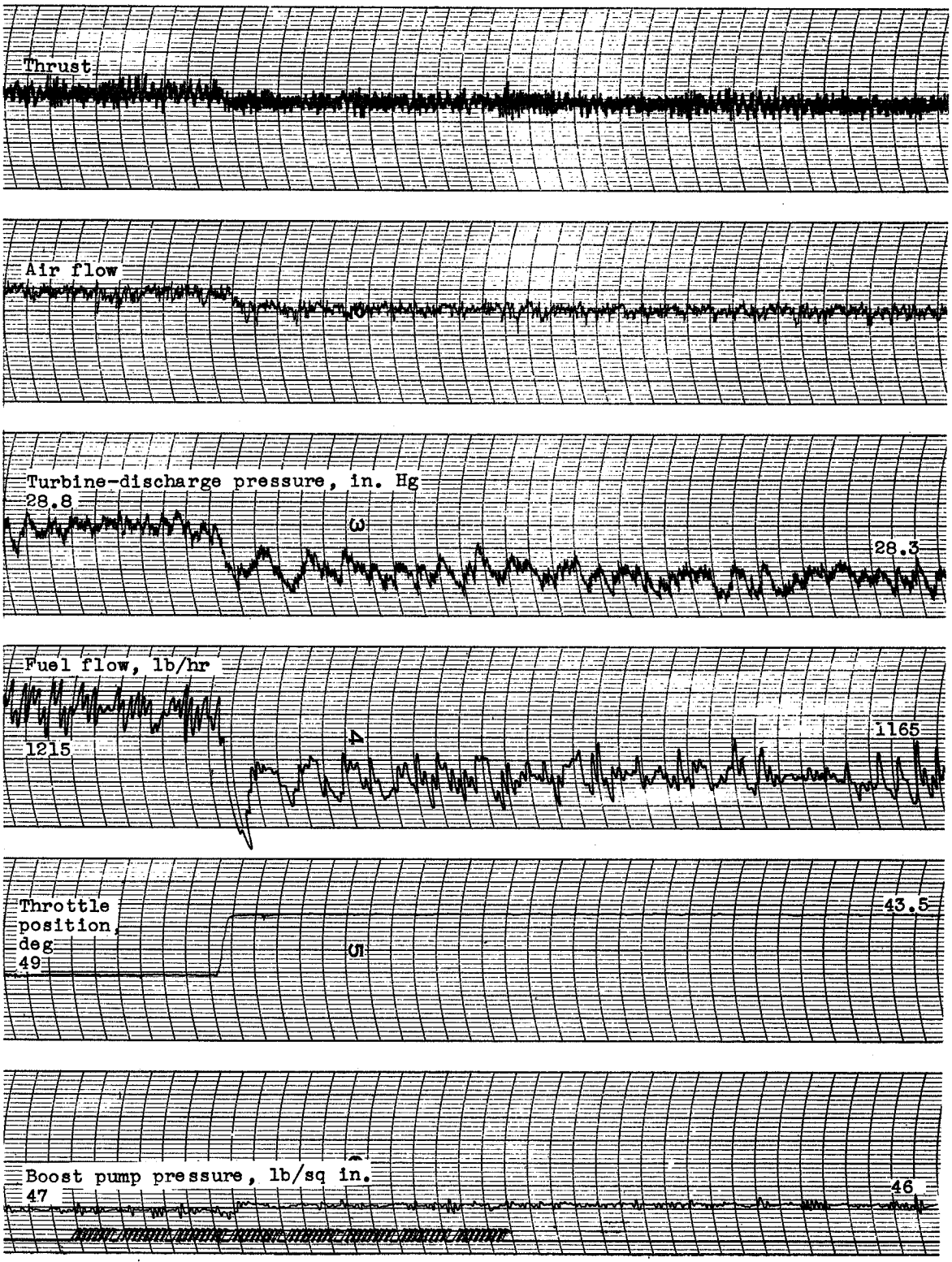
(a) Concluded. - Acceleration.

Figure 5. - Continued. Transient operation of automatically-controlled engine. Throttle position, 43.5° to 49.0°; altitude, 10,000 feet, nominal ram-pressure ratio, 1.2.



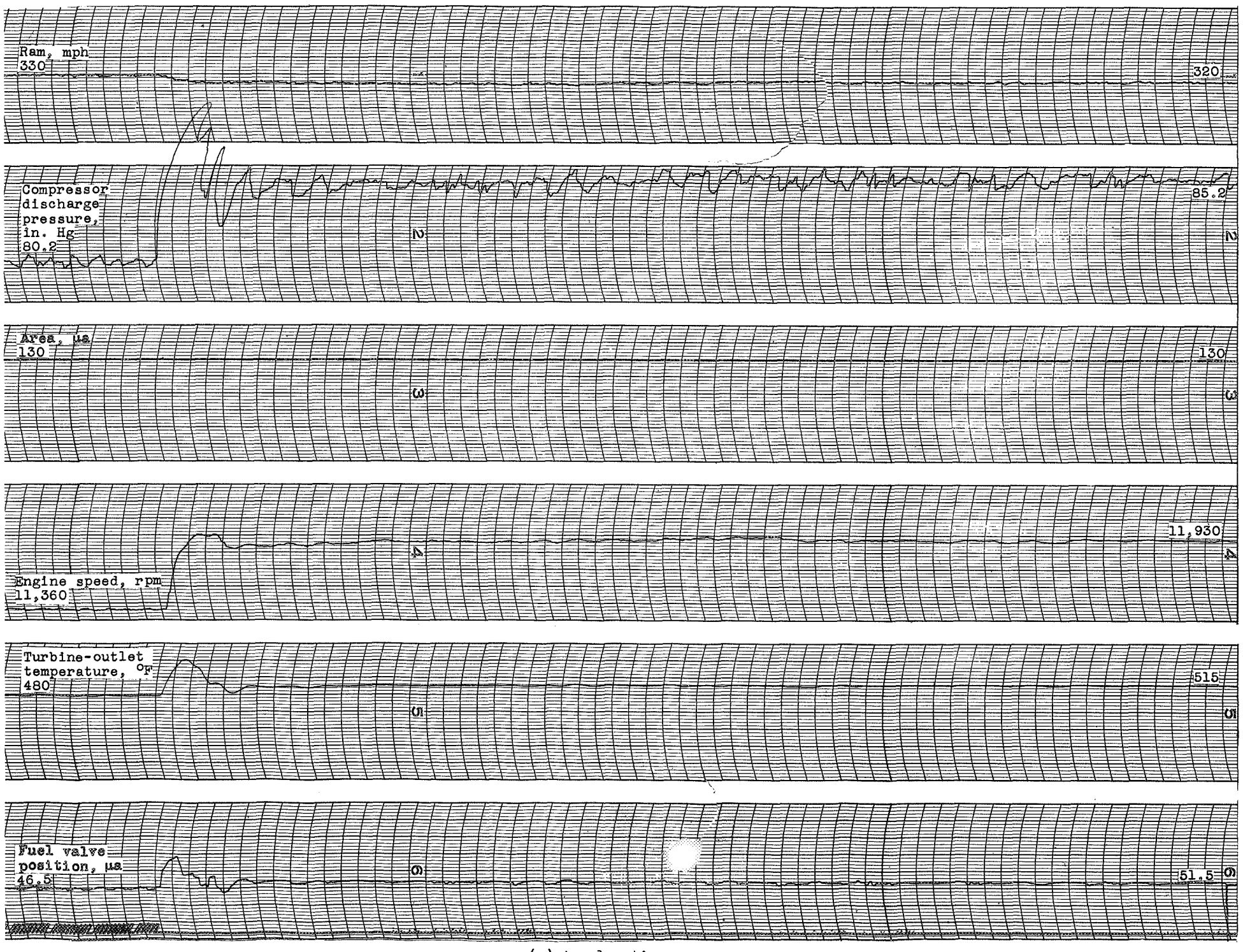
(b) Deceleration.

Figure 5. - Continued. Transient operation of automatically-controlled engine. Throttle position, 43.5° to 49.0°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



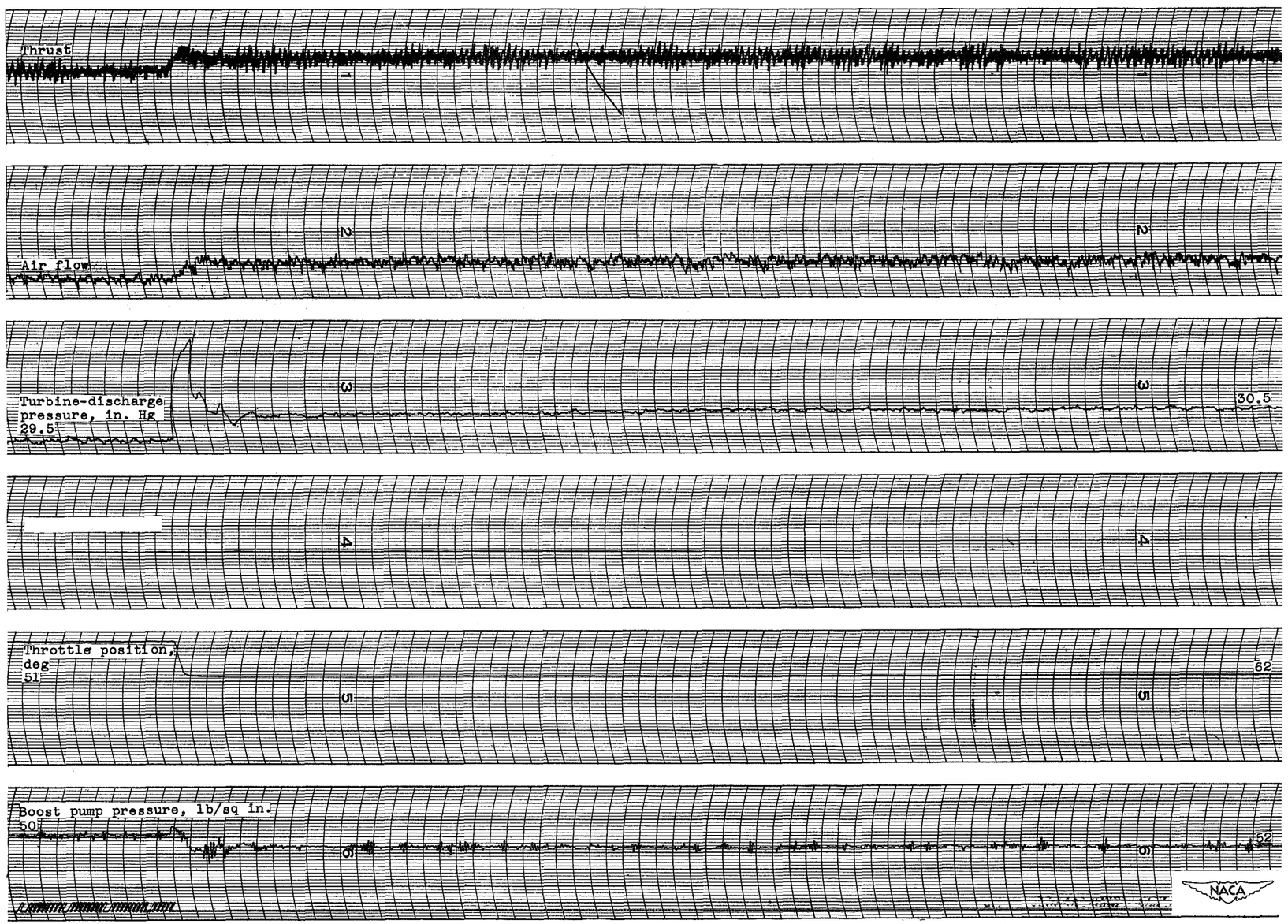
(b) Concluded. - Deceleration.

Figure 5. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 43.5° to 49.0°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



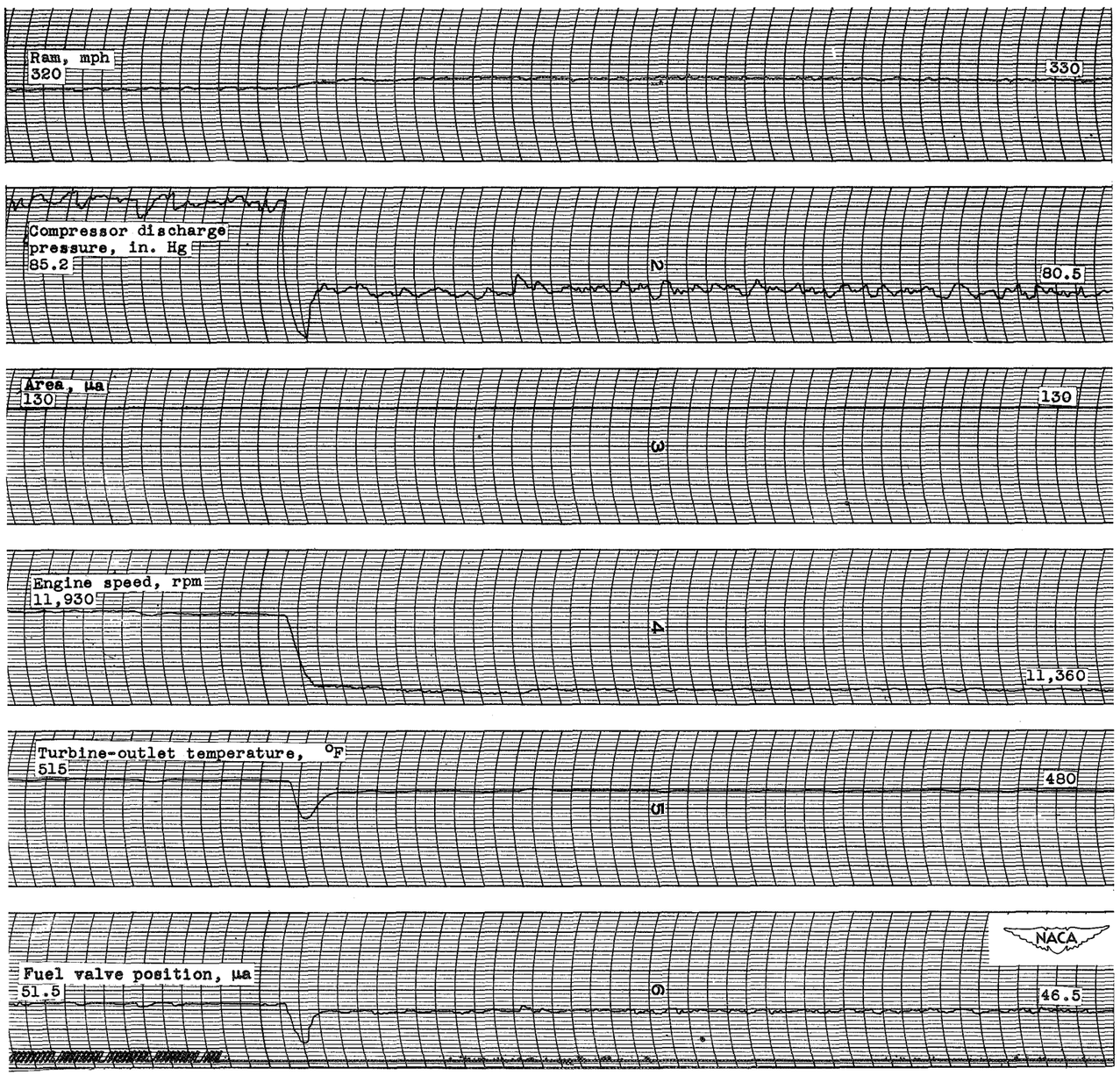
(a) Acceleration.

Figure 6. - Transient operation of automatically-controlled engine. Throttle position, 51° to 82°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



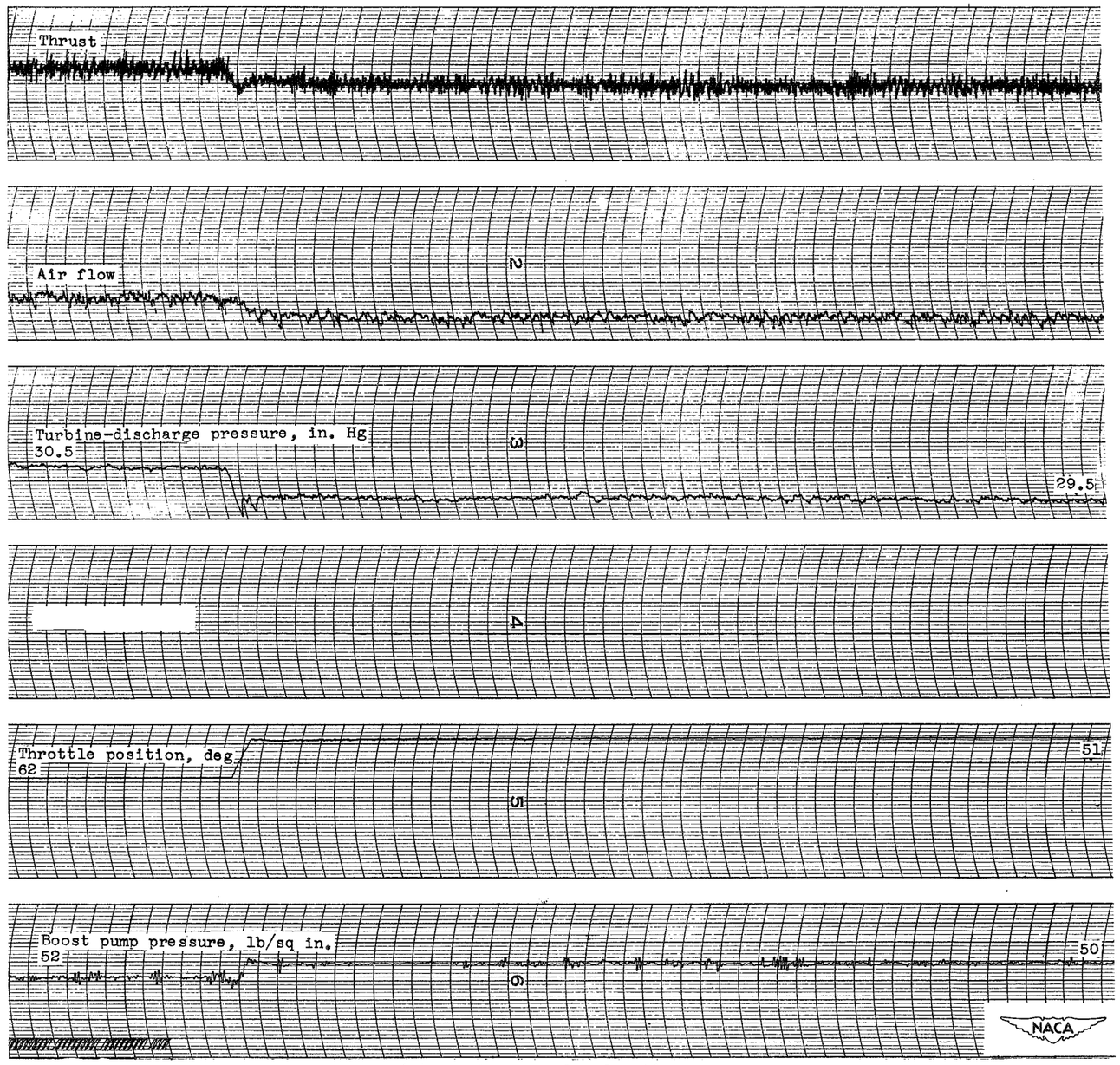
(a) Concluded. - Acceleration.

Figure 6. - Continued. Transient operation of automatically-controlled engine. Throttle position, 51° to 62°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



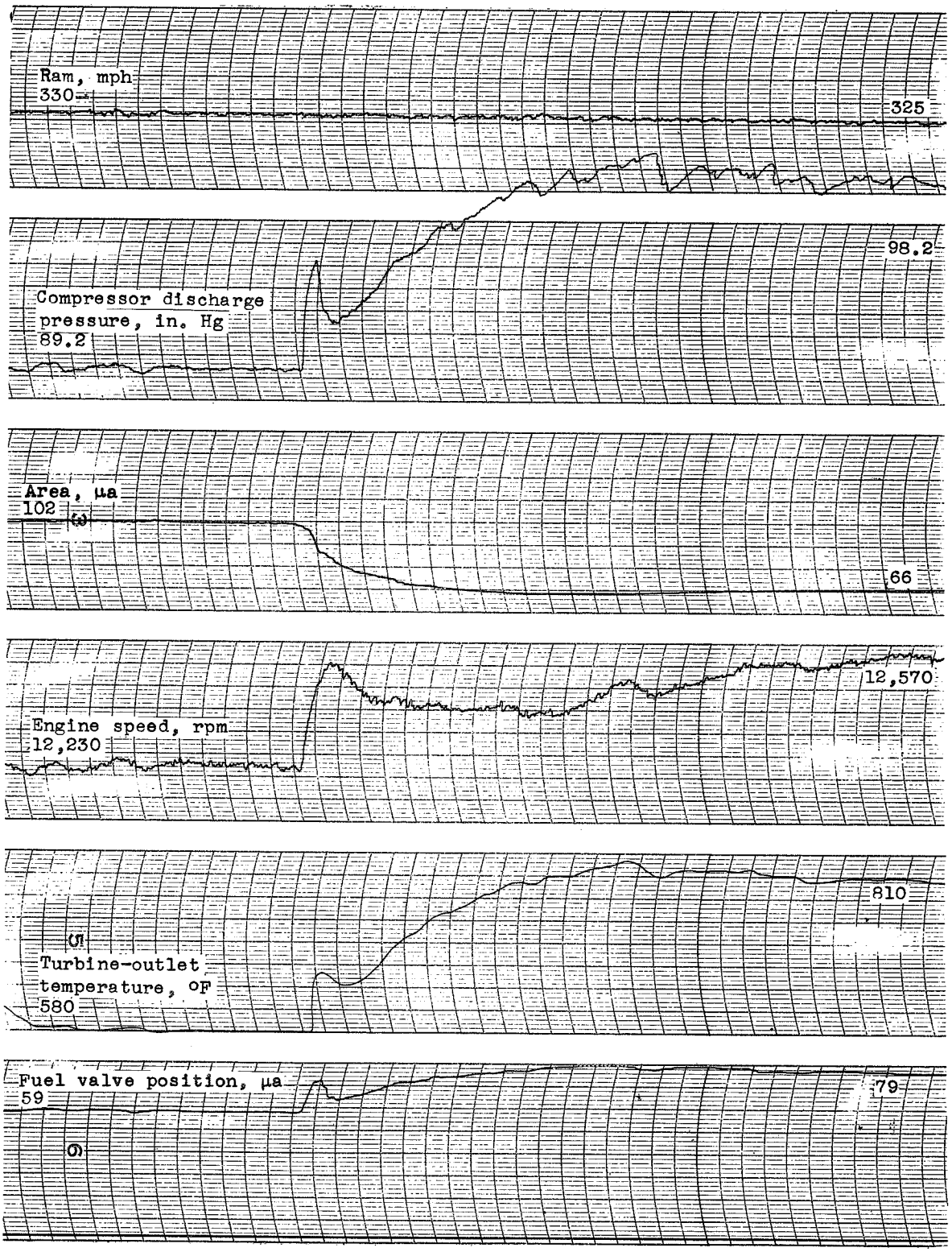
(b) Deceleration.

Figure 6. - Continued. Transient operation of automatically-controlled engine. Throttle position, 51° to 52°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



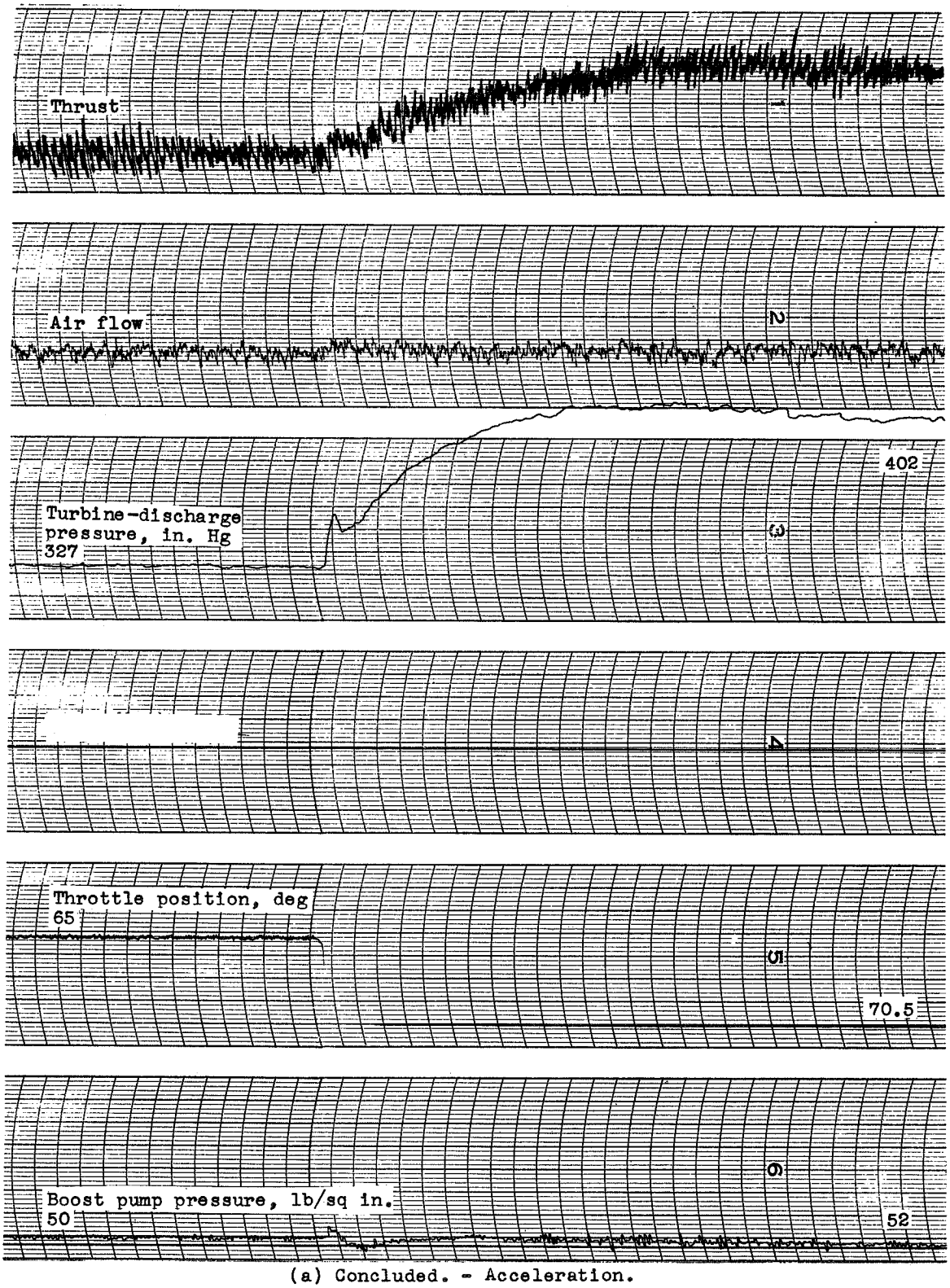
(b) Concluded. - Deceleration.

Figure 6. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 51° to 62°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



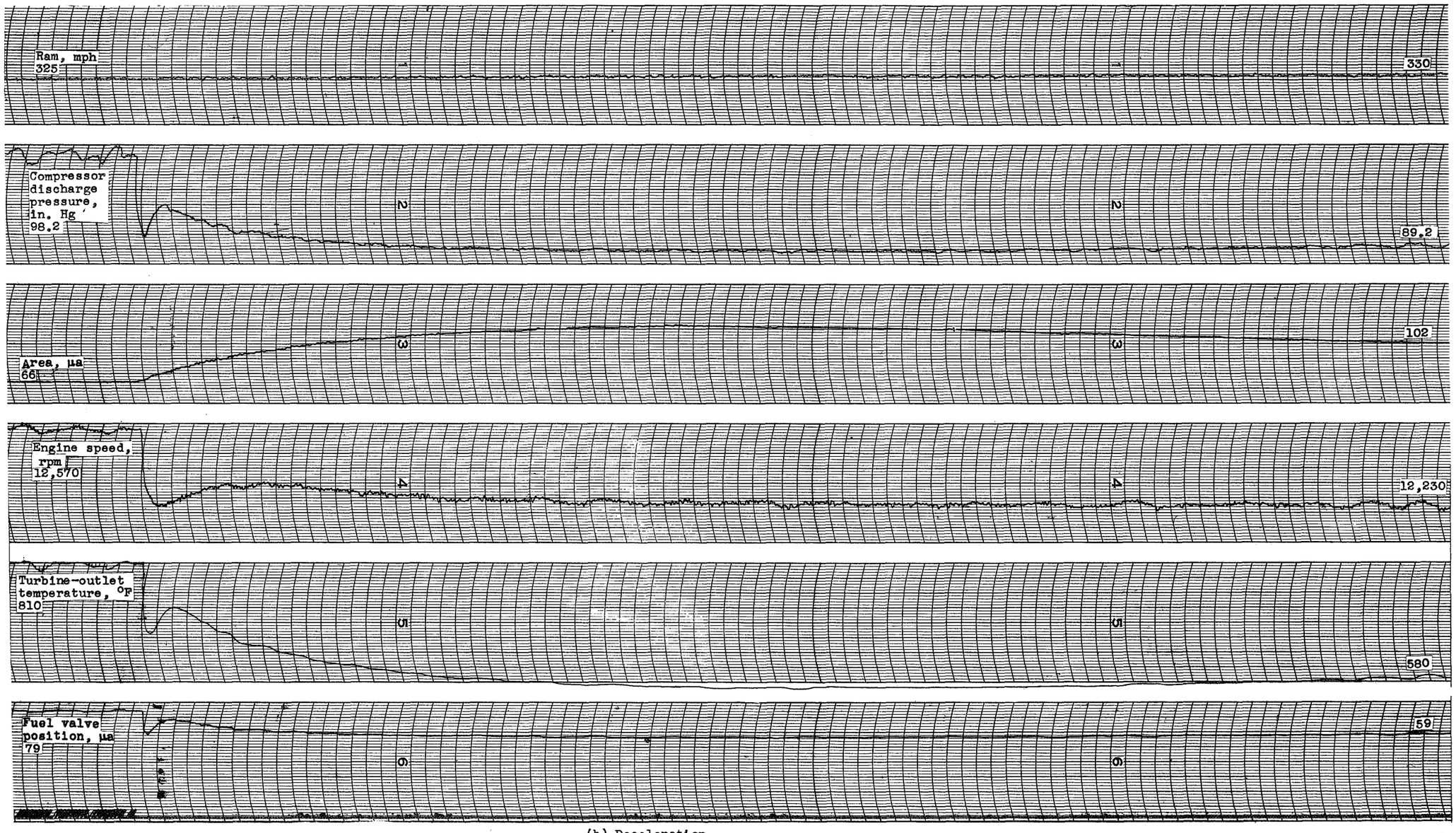
(a) Acceleration.

Figure 7. - Transient operation of automatically-controlled engine. Throttle position, 65° to 70.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



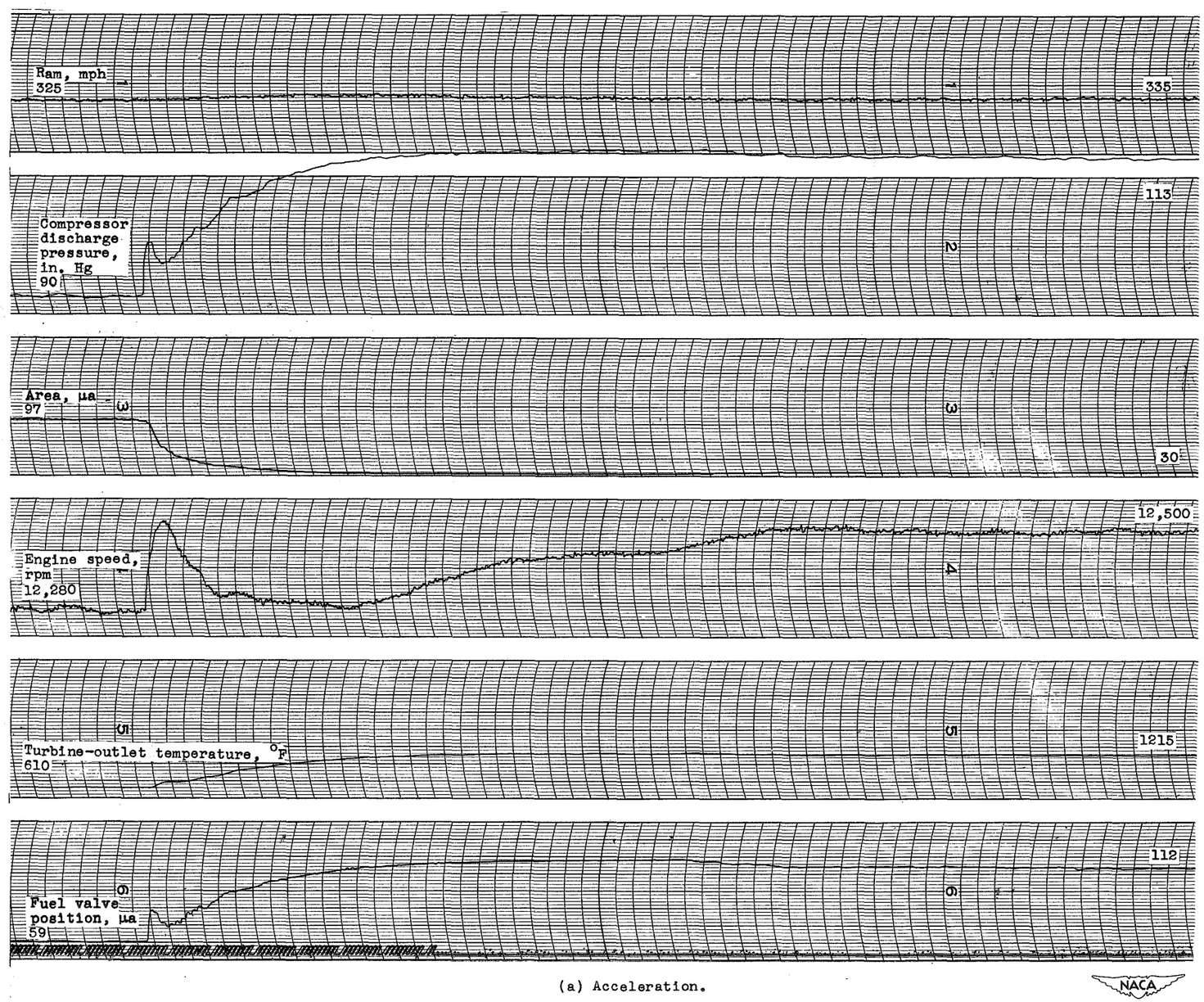
(a) Concluded. - Acceleration.

Figure 7. - Continued. Transient operation of automatically-controlled engine. Throttle position, 65° to 70.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



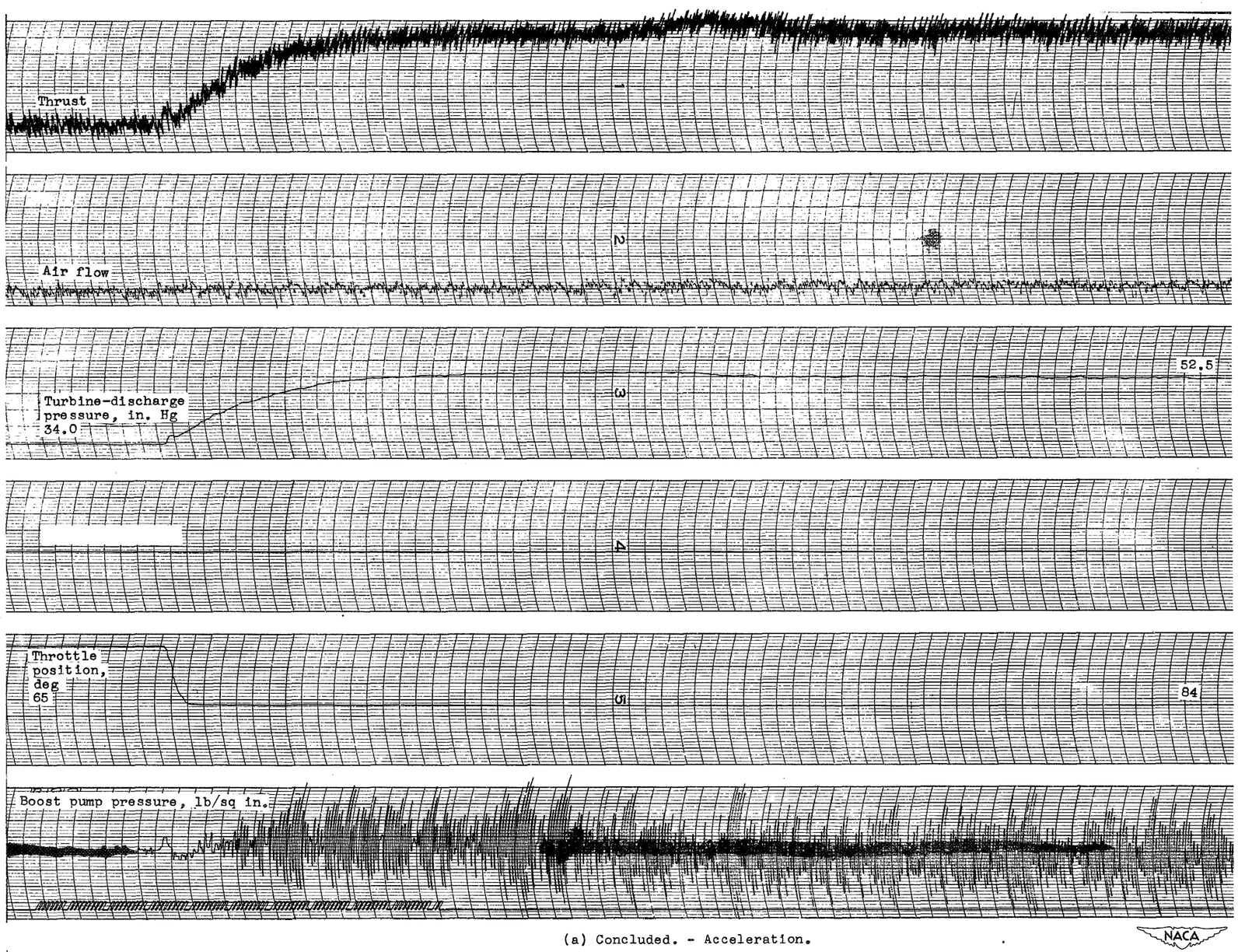
(b) Deceleration

Figure 7. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 65° to 70.5°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



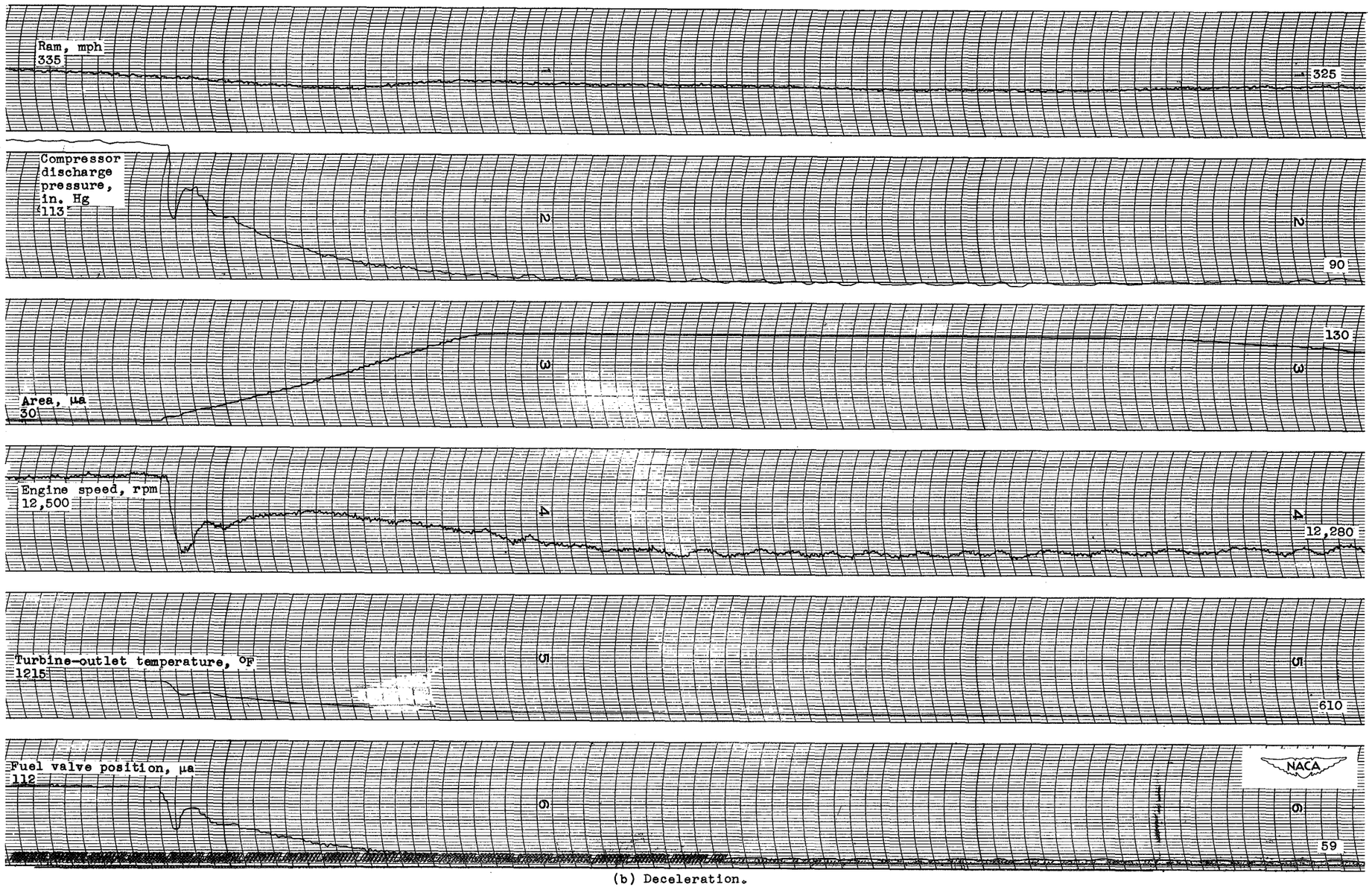
(a) Acceleration.

Figure 8. - Transient operation of automatically-controlled engine. Throttle position, 65° to 84°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



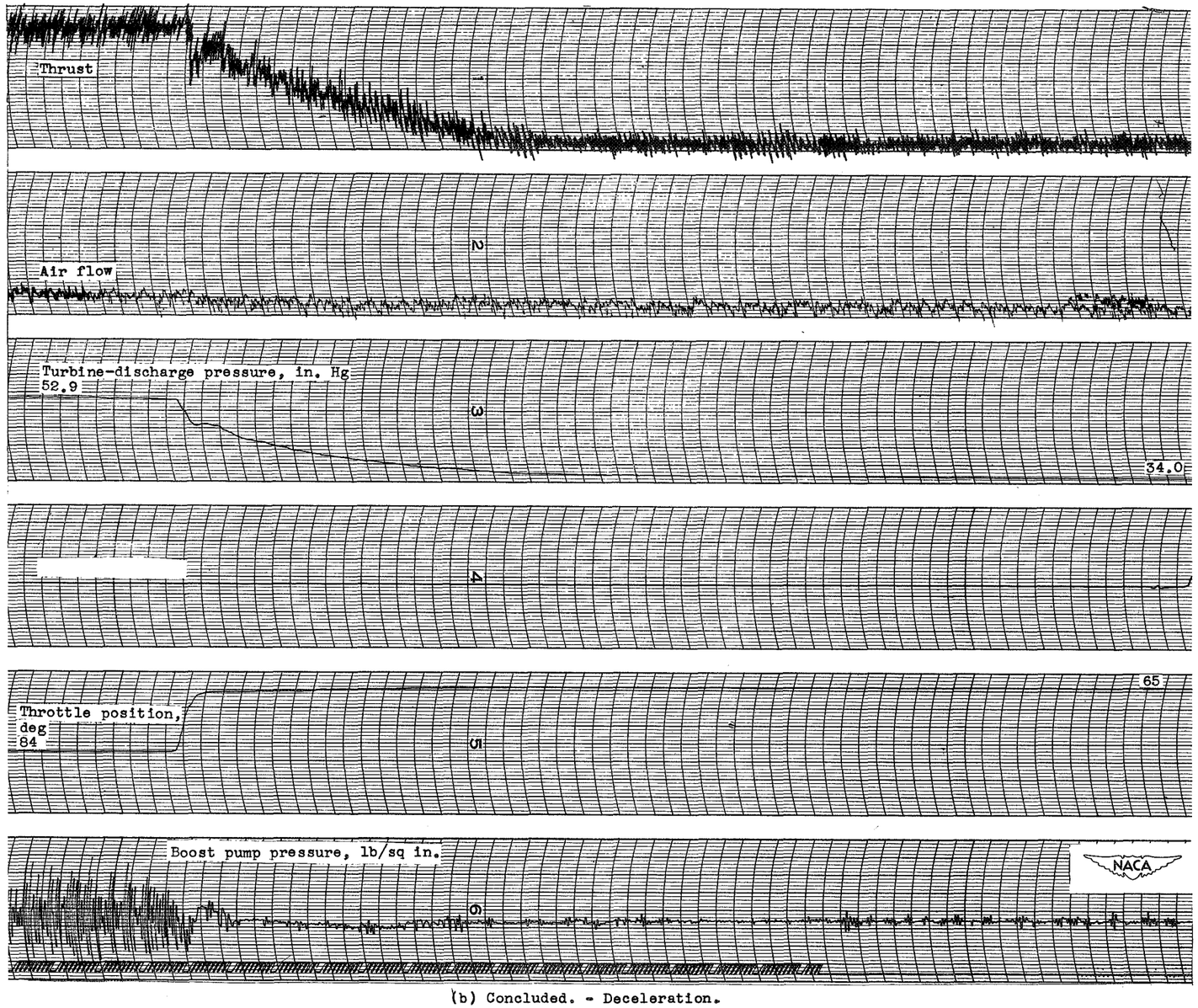
(a) Concluded. - Acceleration.

Figure 8. - Continued. Transient operation of automatically-controlled engine. Throttle position, 65° to 84°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



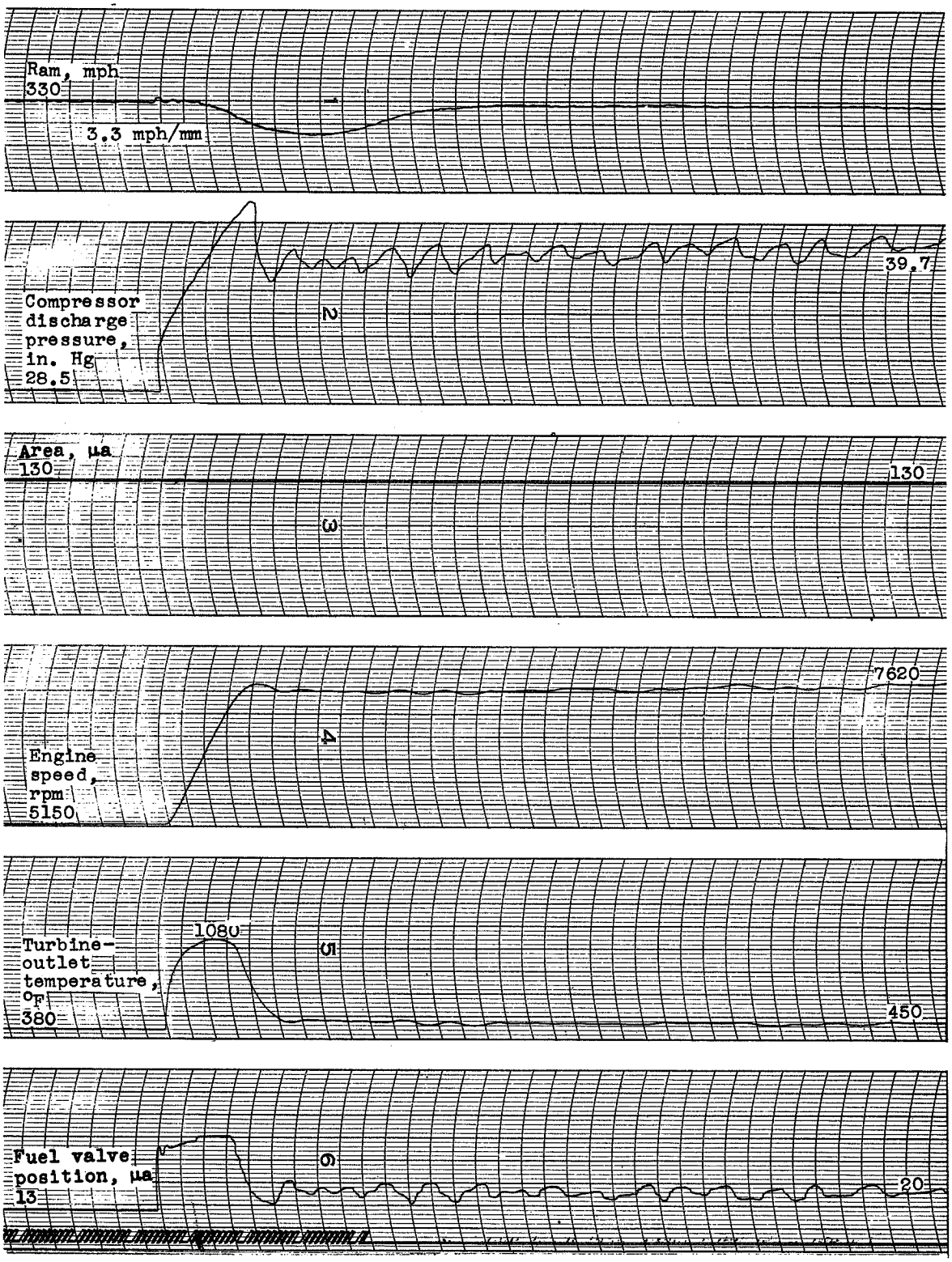
(b) Deceleration.

Figure 8. - Continued. Transient operation of automatically-controlled engine. Throttle position, 65° to 84°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



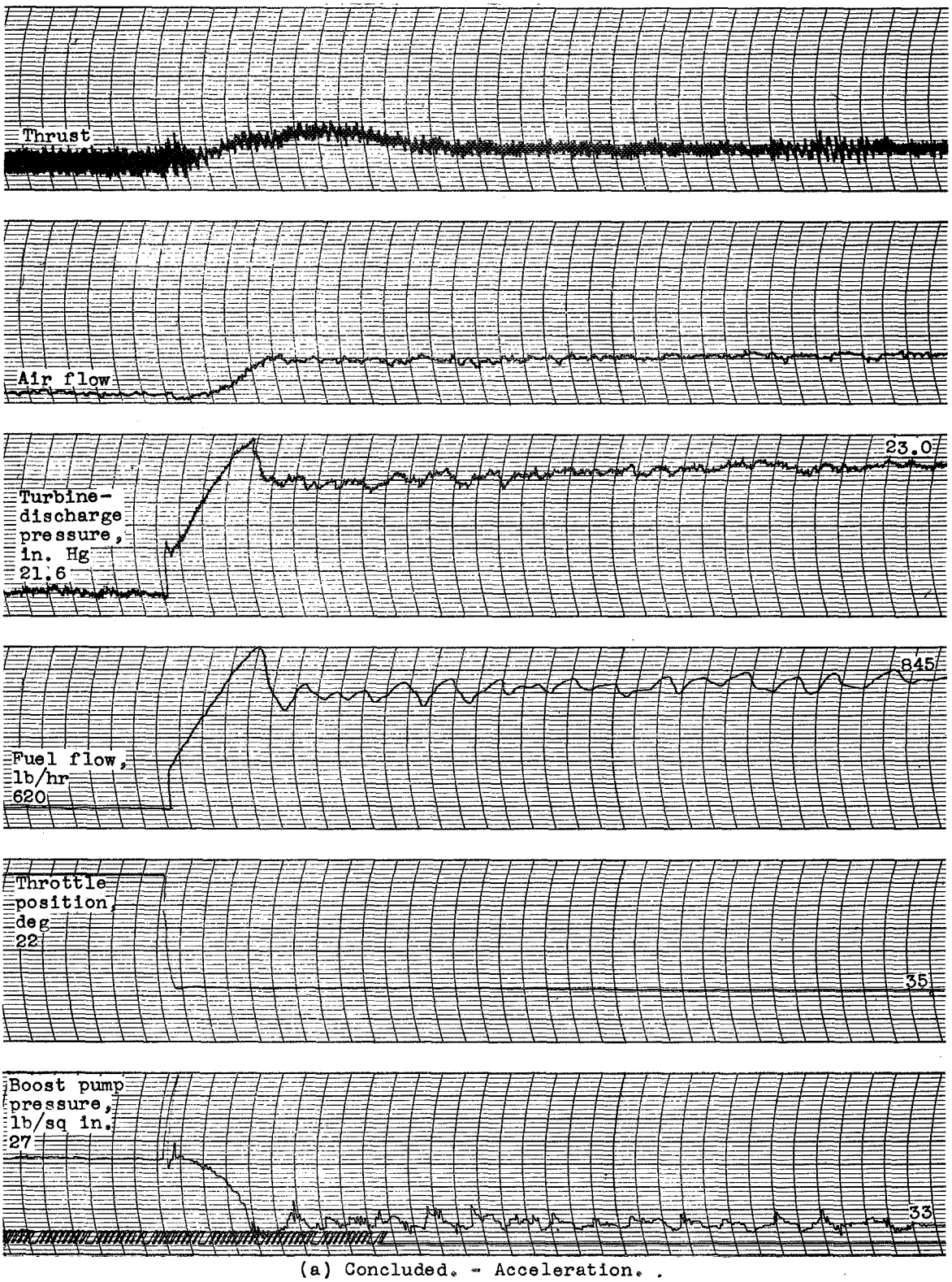
(b) Concluded. - Deceleration.

Figure 8. - Concluded. Transient operation of automatically-controlled engine. Throttle pogition, 65° to 84°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



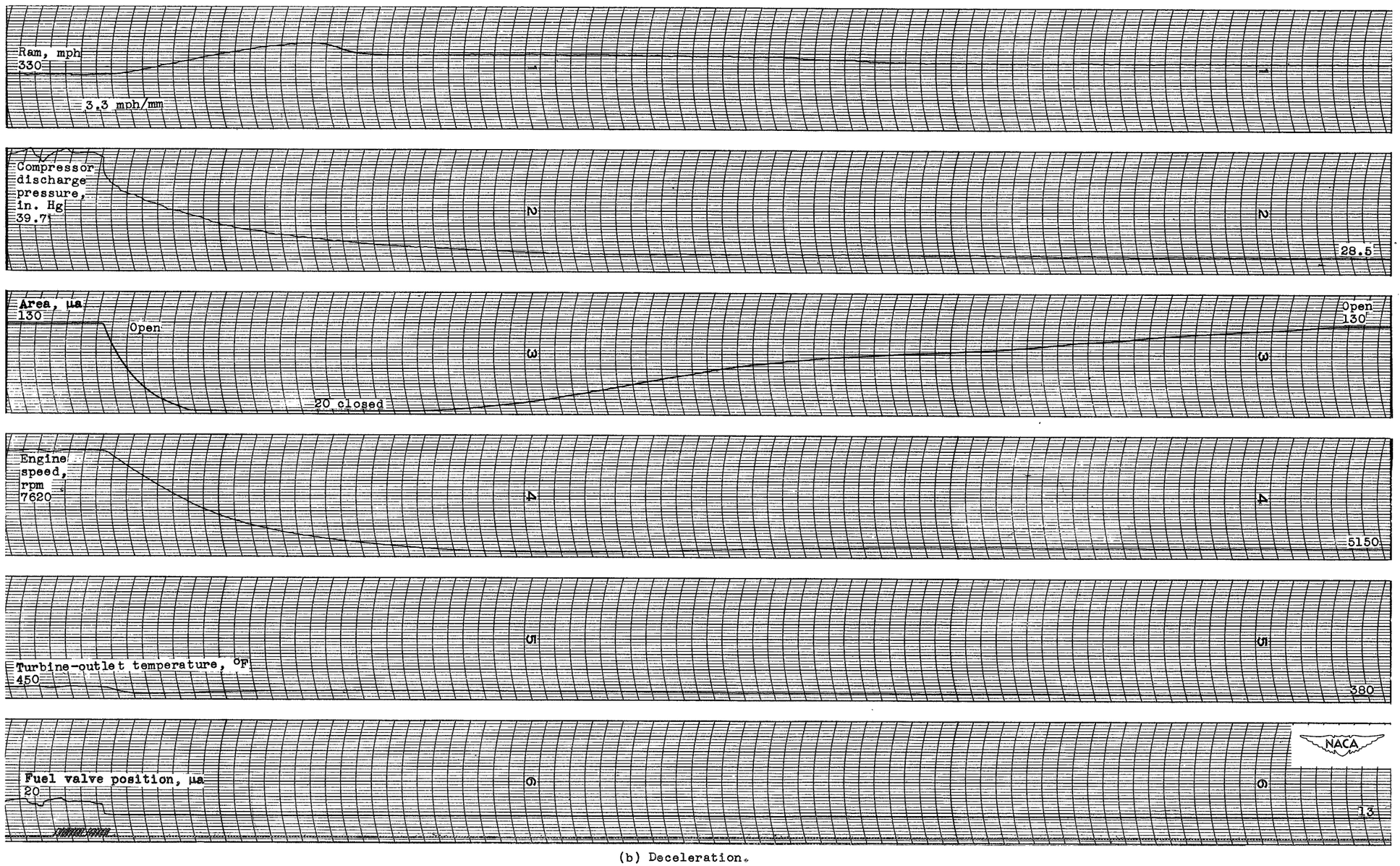
(a) Acceleration.

Figure 9. - Transient operation of automatically-controlled engine. Throttle position, 22° to 35°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



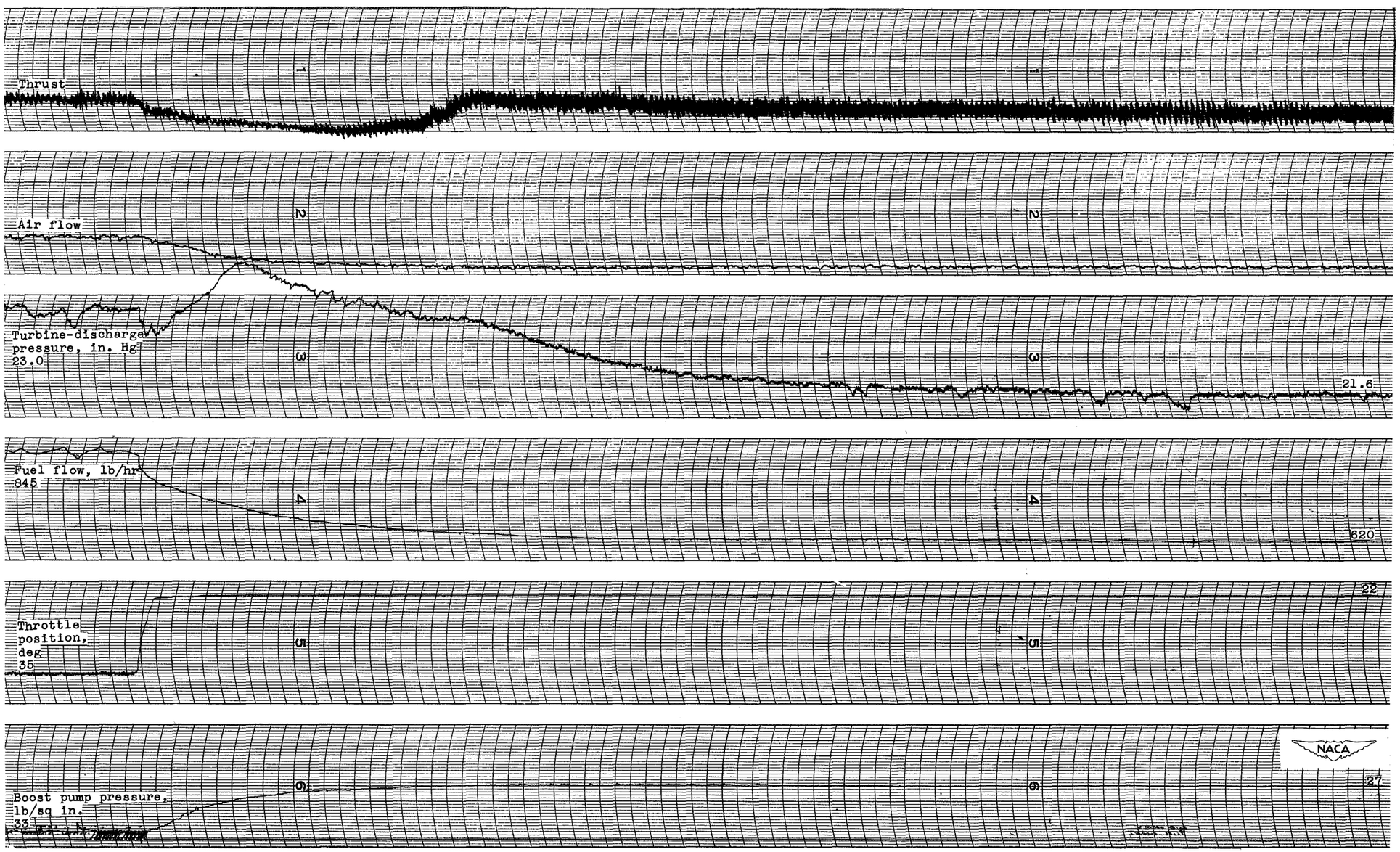
(a) Concluded. - Acceleration.

Figure 9. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 35°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 9. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 35°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 9. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22° to 35°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.

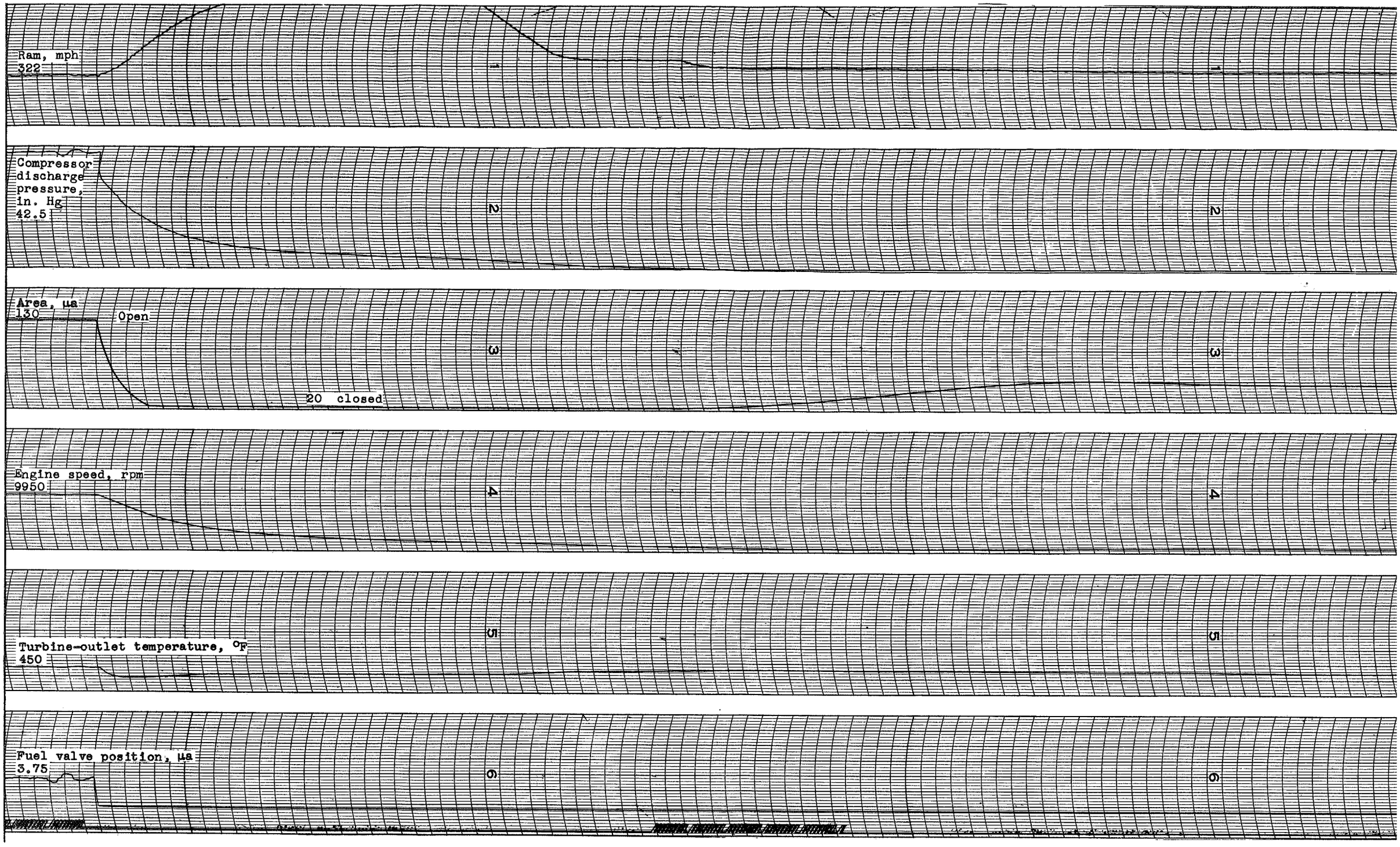
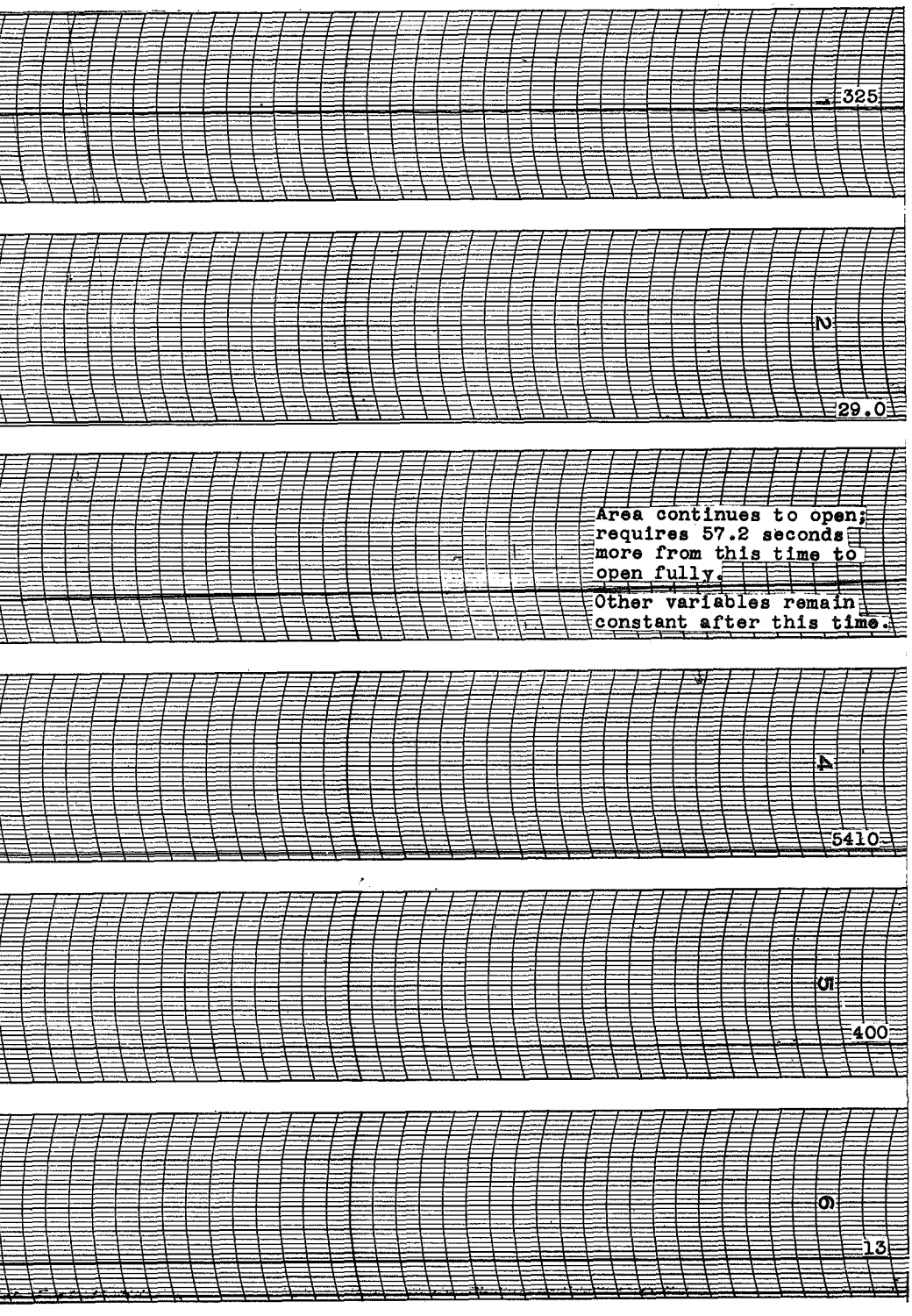


Figure 10. - Transient deceleration of automatically-controlled engine. Throttle position, 42° to 22°; altitude, 10,000 feet; nominal ram-pr



ssure ratio, 1.2;.

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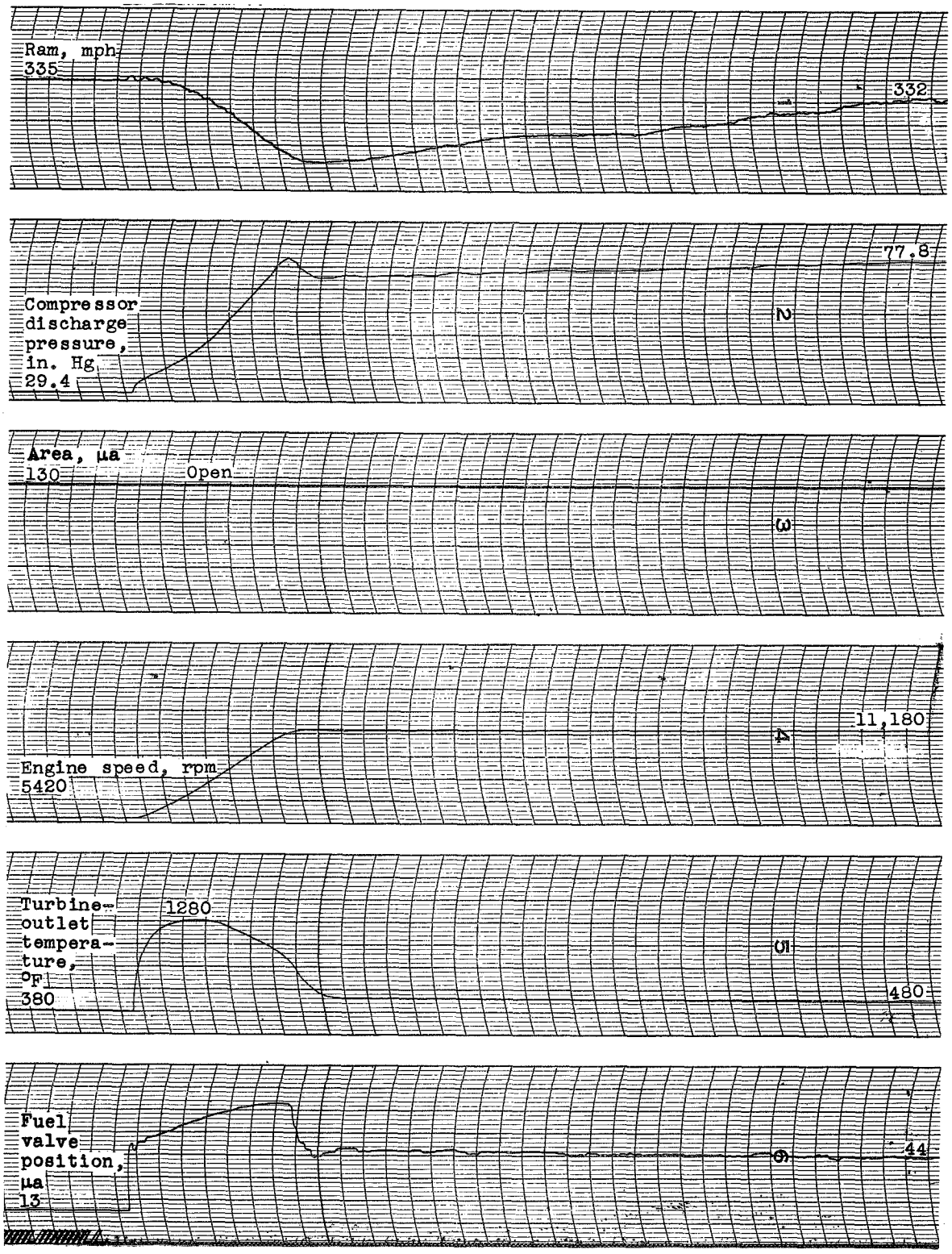
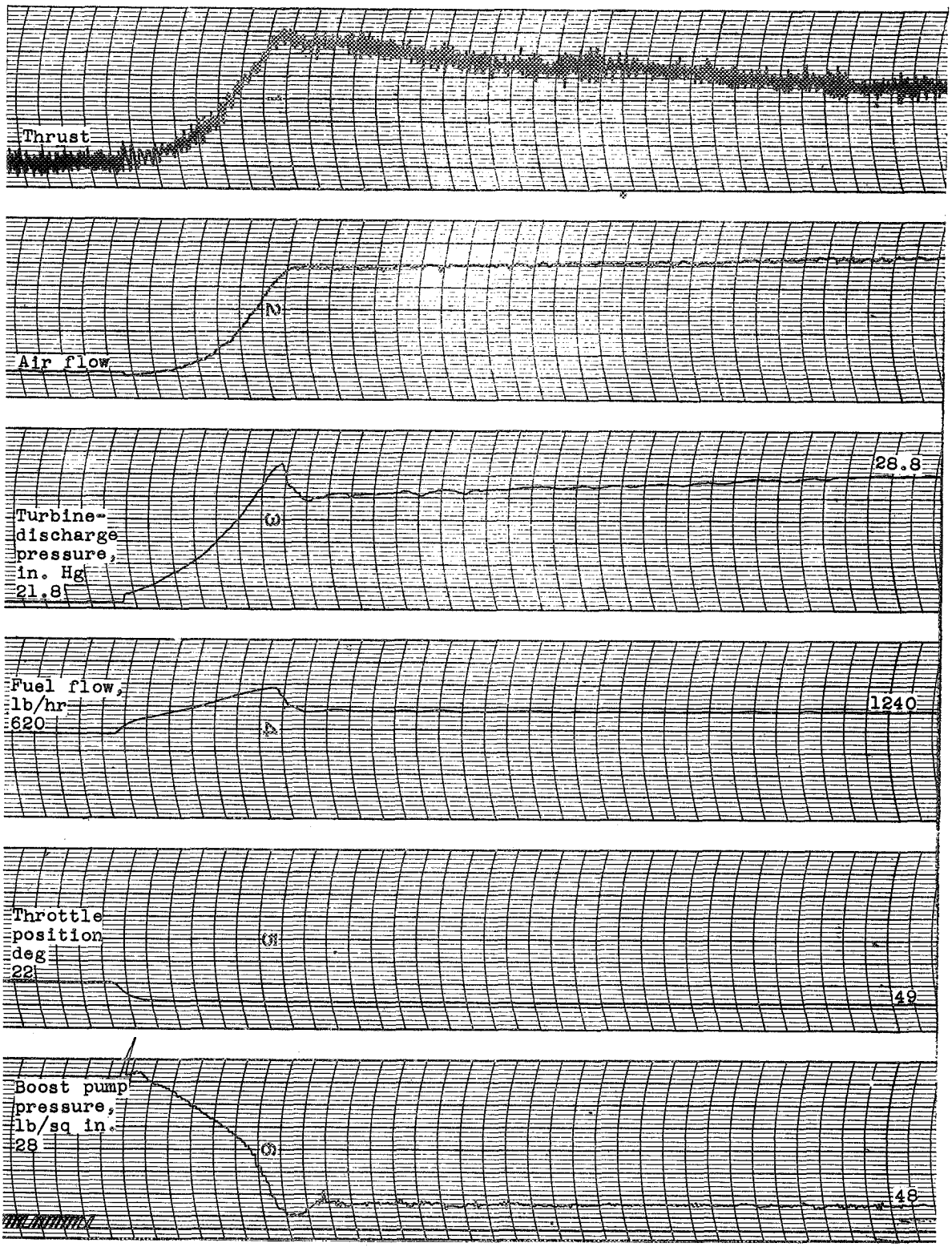


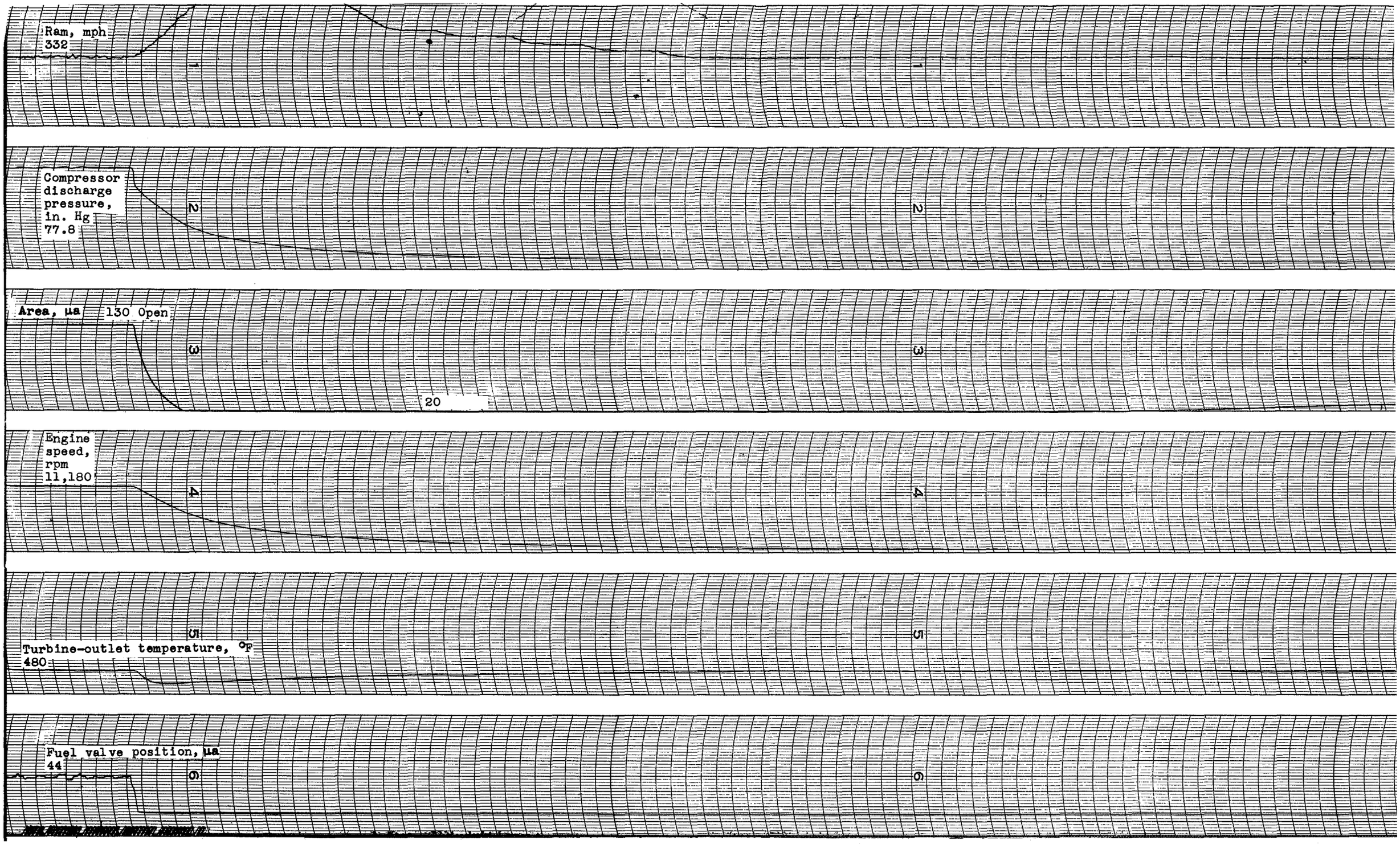
(a) Acceleration.

Figure 11. - Transient operation of automatically-controlled engine. Throttle position, 22° to 49°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



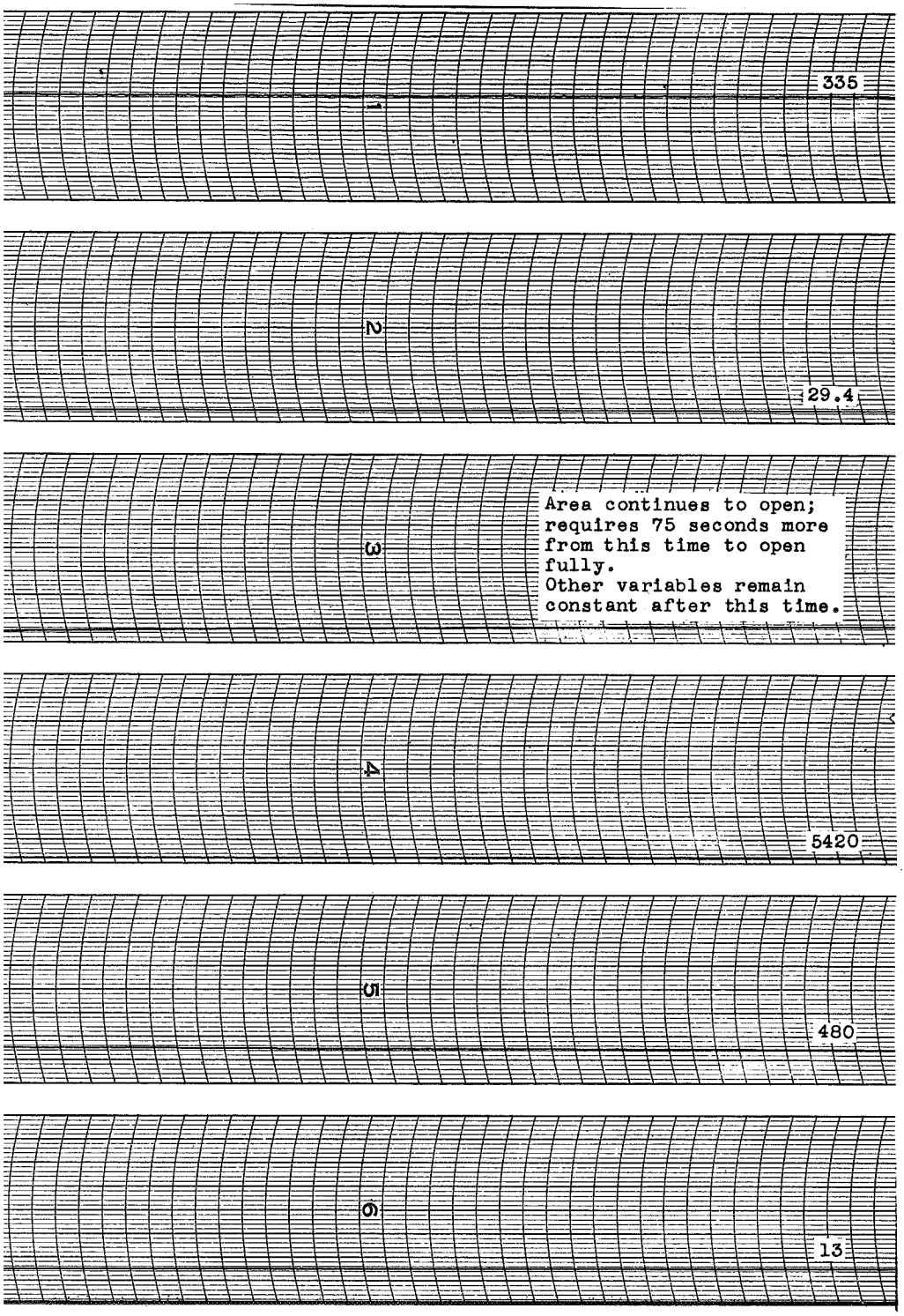
(a) Concluded. - Acceleration.

Figure 11. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 49°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 11. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 49°; altitude, 10,000 feet; nomi



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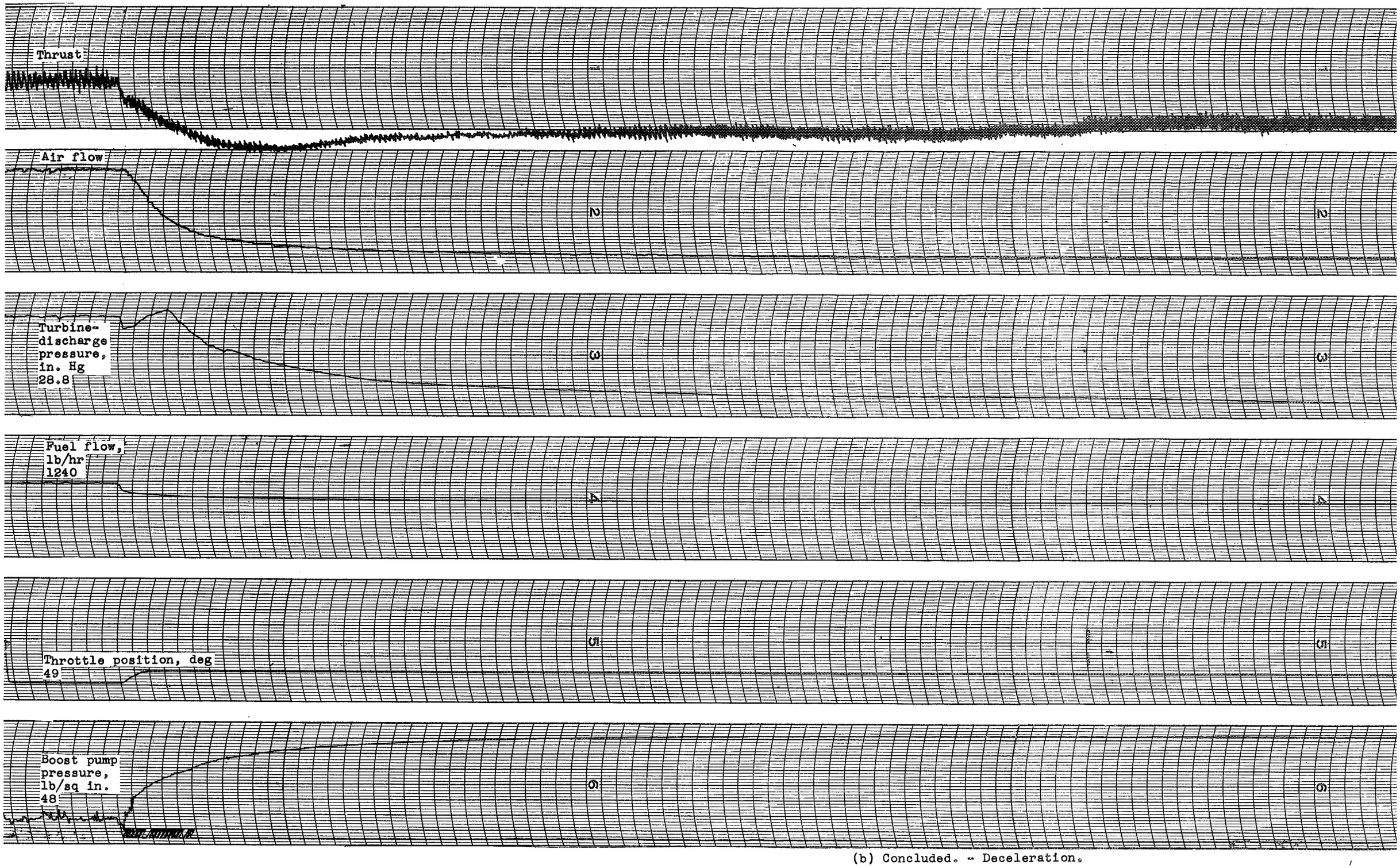
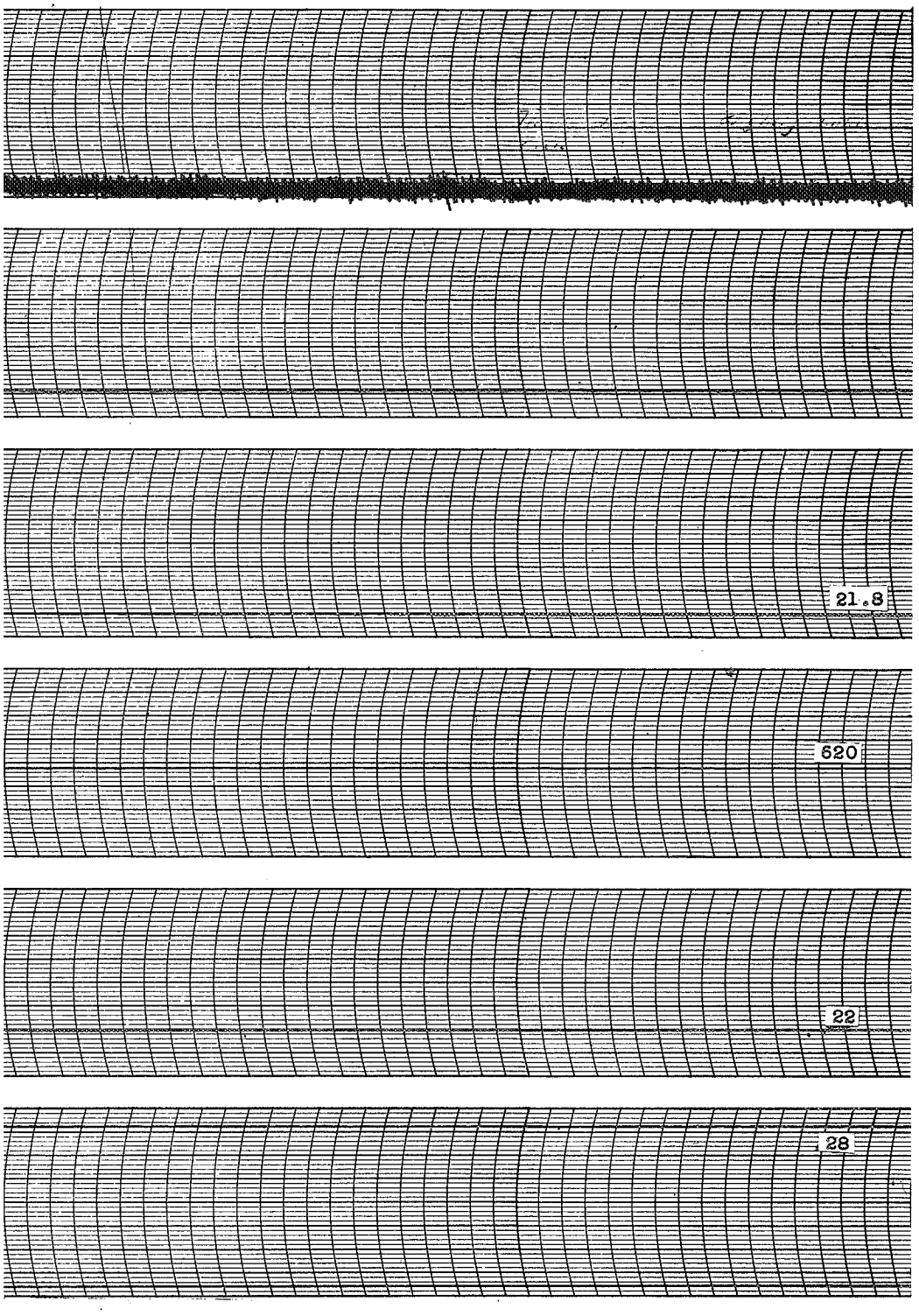
ıl ram-pressure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 11. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22° to 49°; altitude, 10,000 feet



nominal ram-pressure ratio, 1.2.

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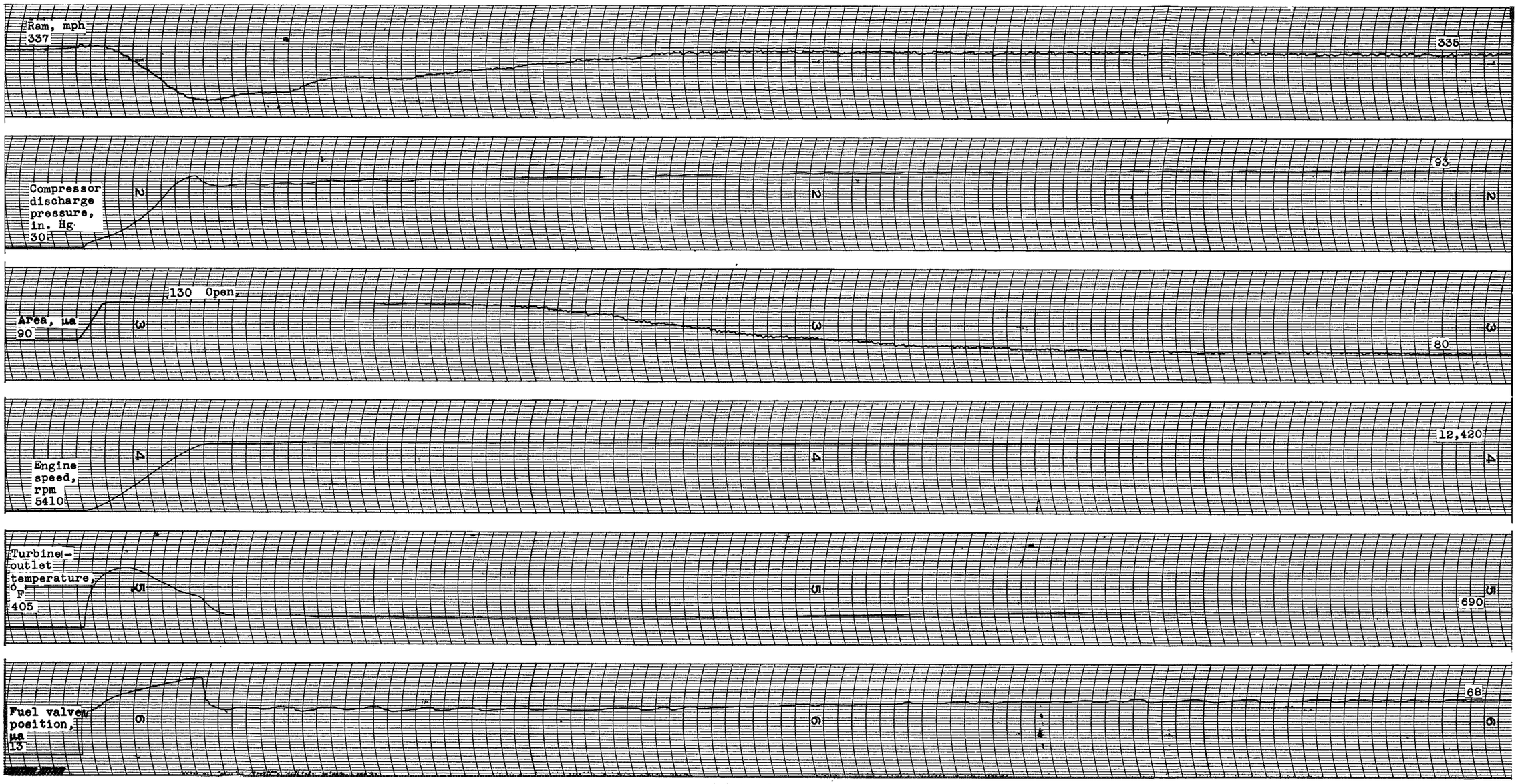
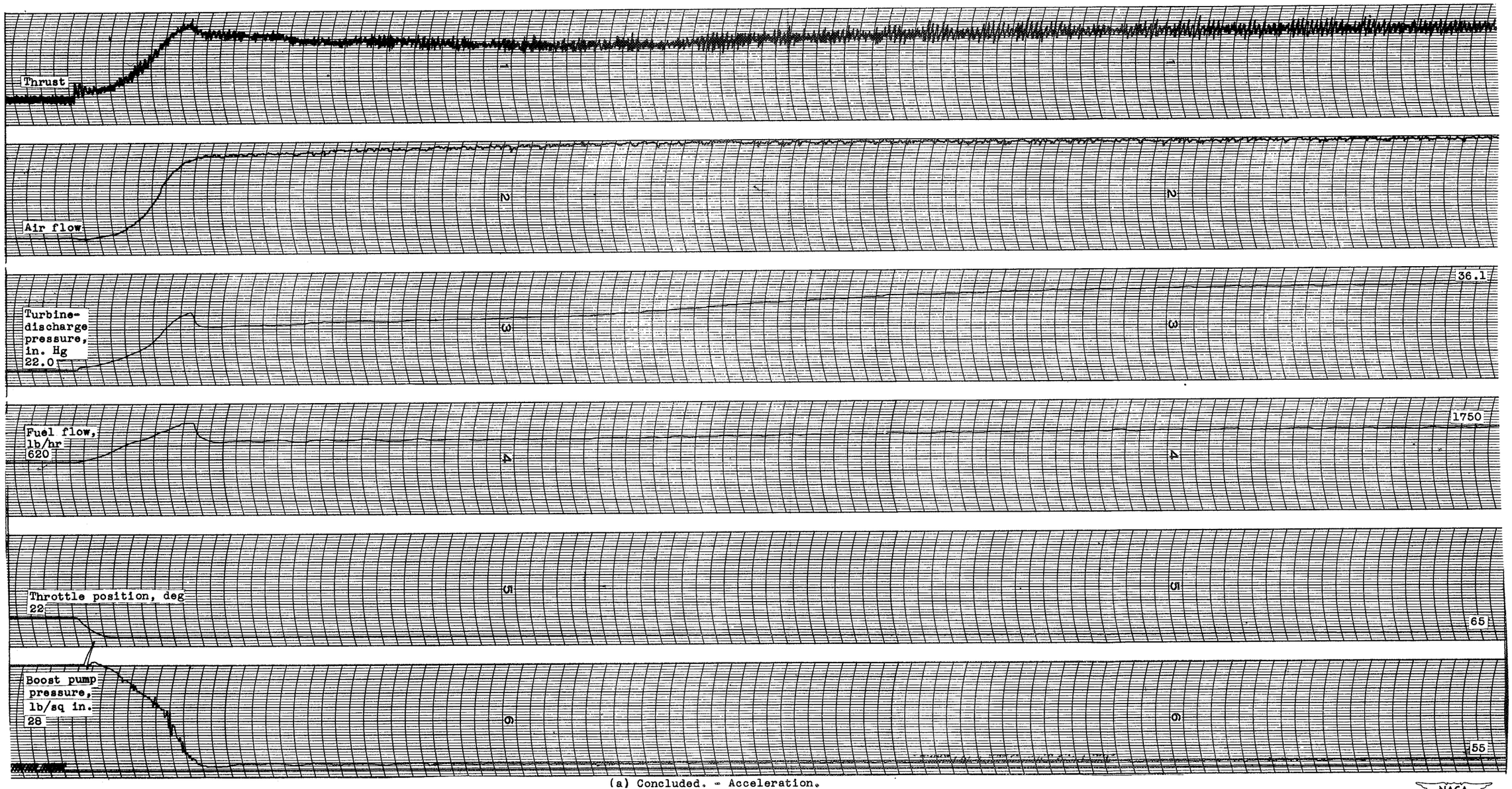


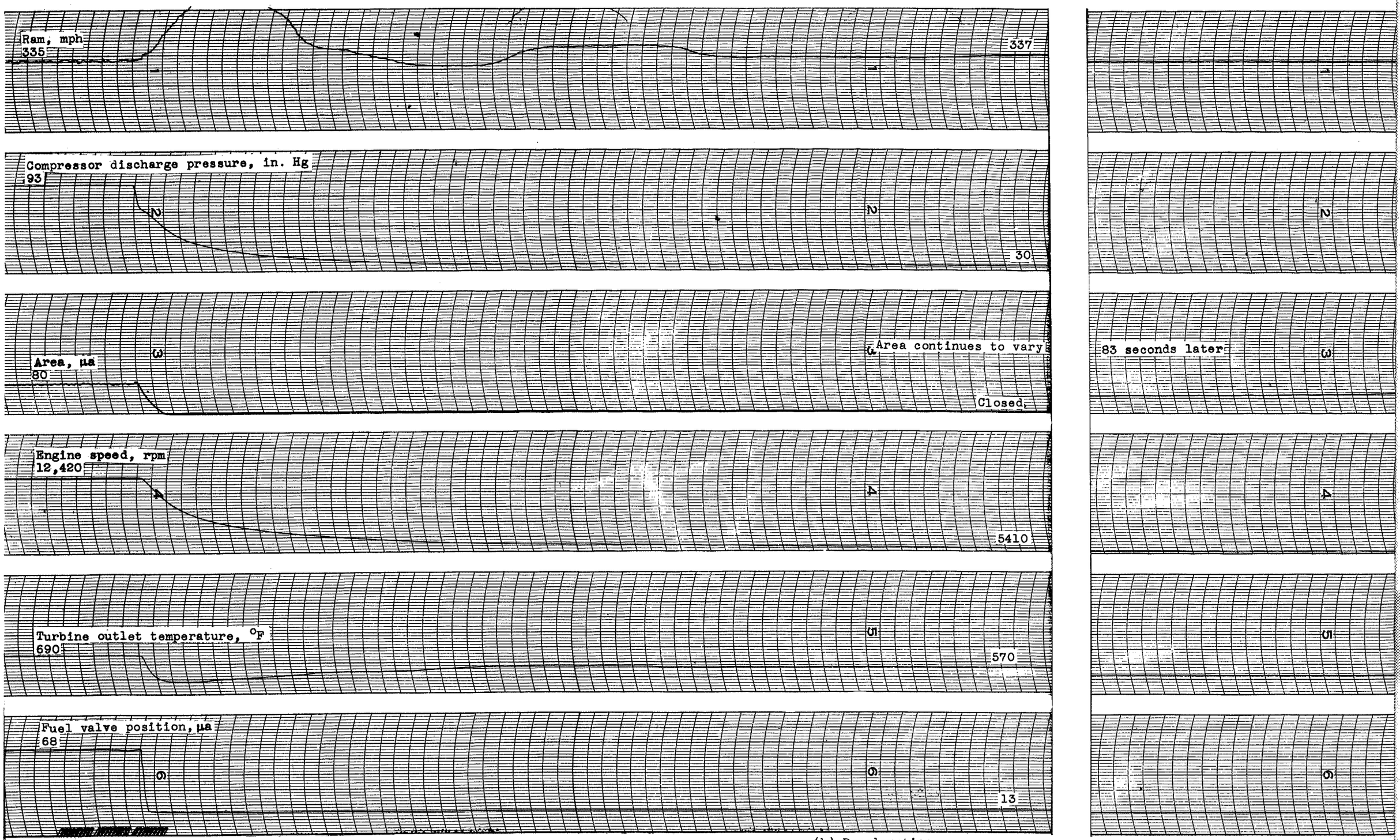
(a) Acceleration.

Figure 12. - Transient operation of automatically-controlled engine. Throttle position, 22° to 65°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



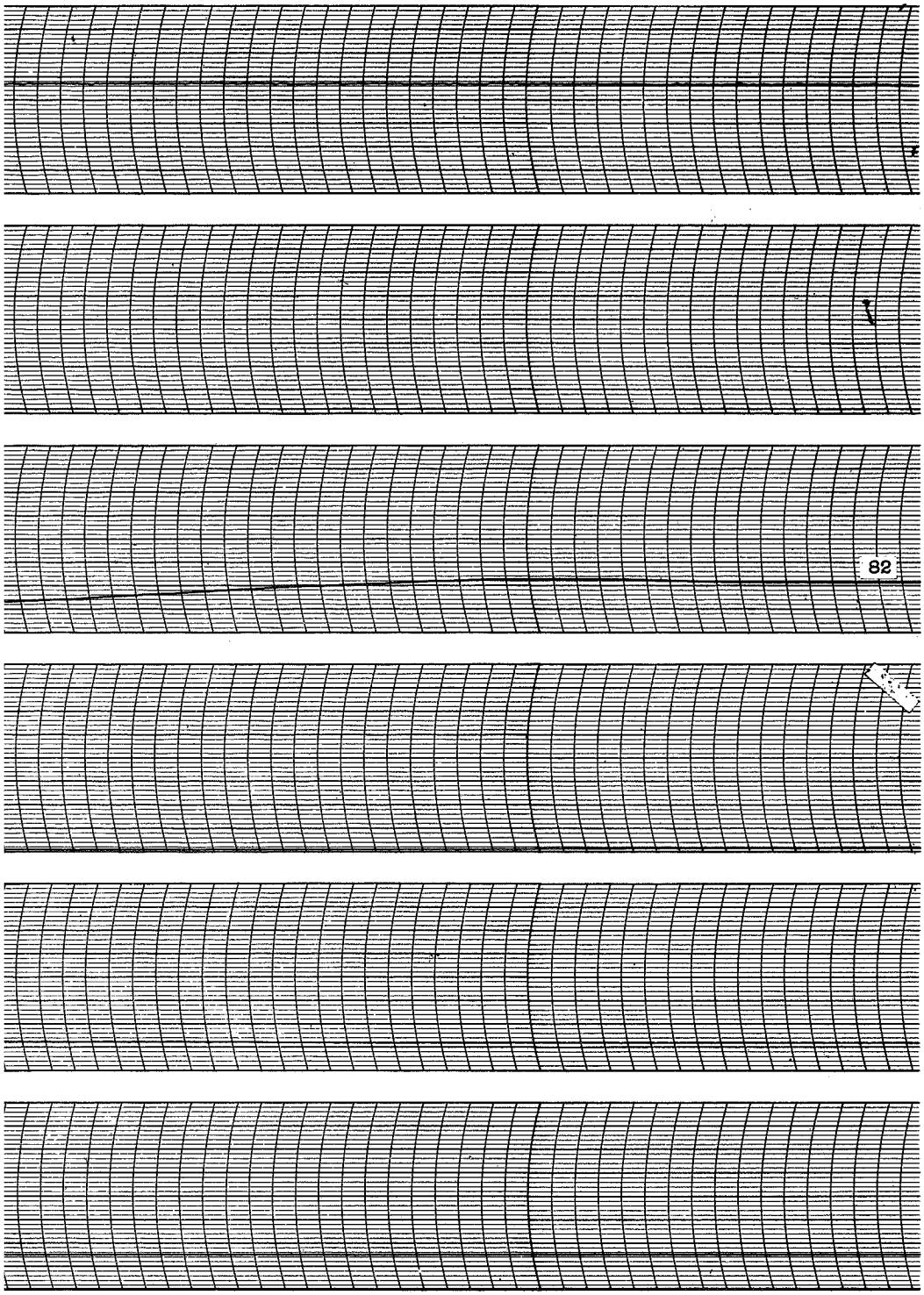
(a) Concluded. - Acceleration.

Figure 12. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 65°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.

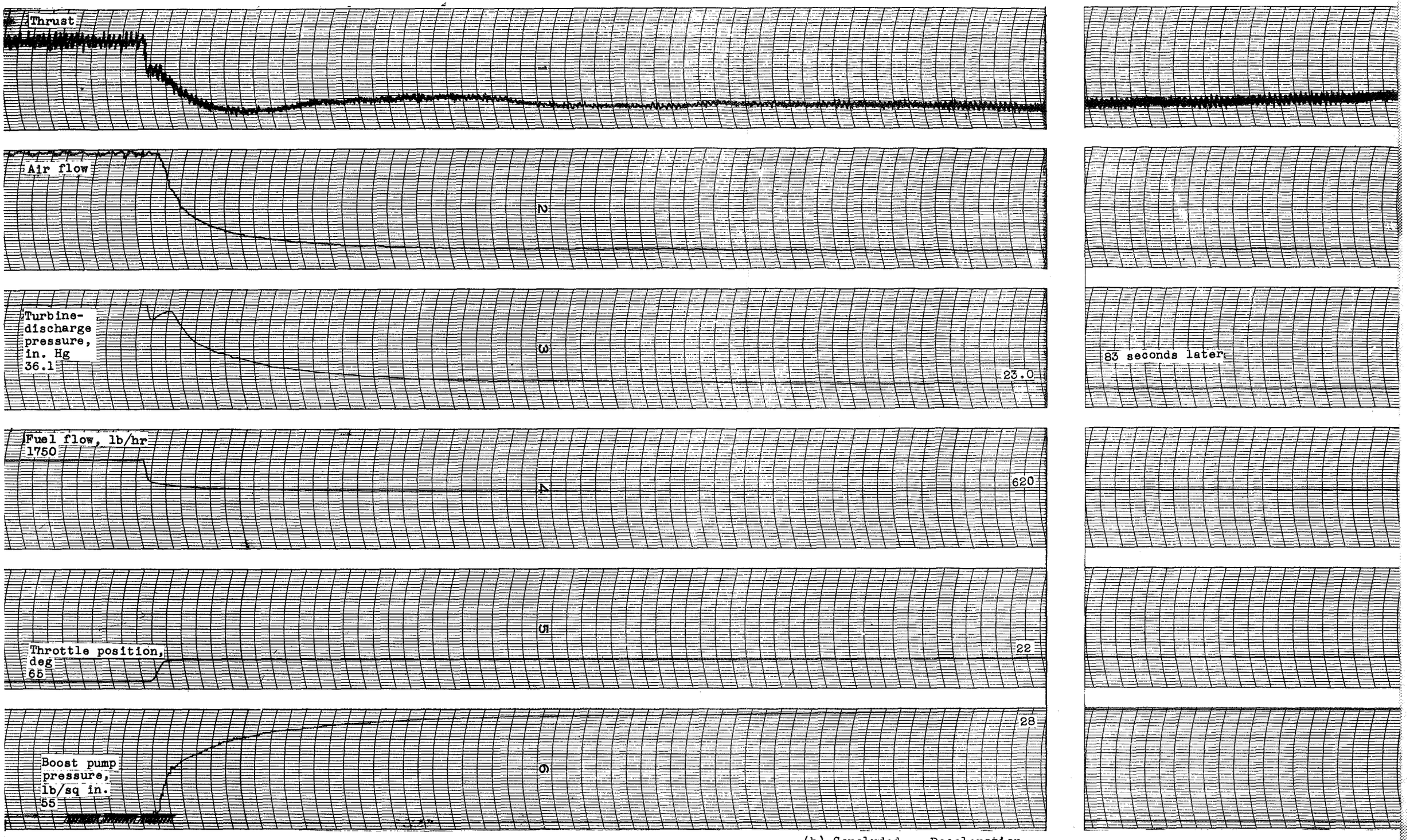


(b) Deceleration.

Figure 12. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 65°; altitude, 10,000 feet; nominal ram-pre

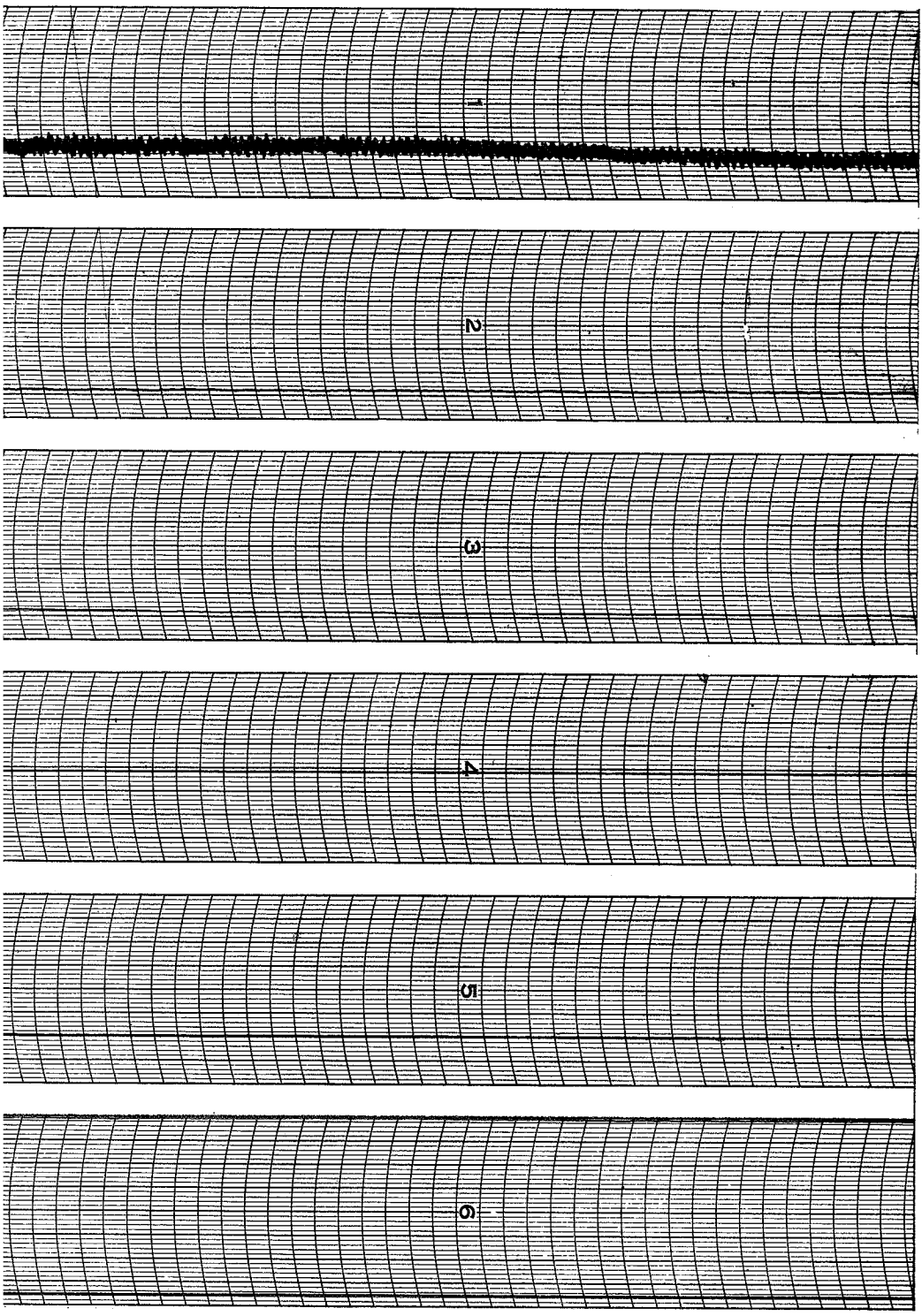


sure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 12. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22° to 65°; altitude, 10,000 feet; nominal



ram-pressure ratio, 1.2.

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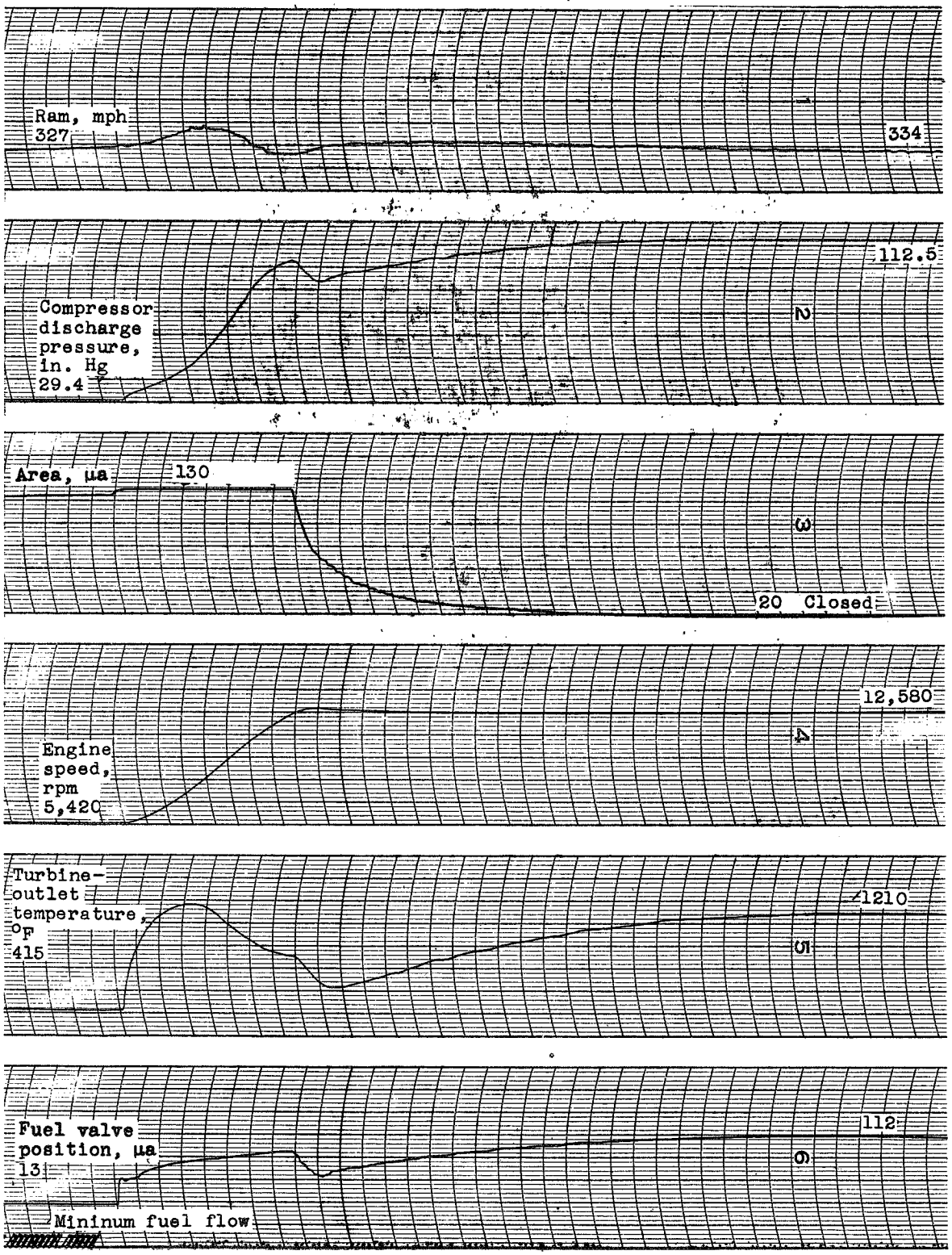
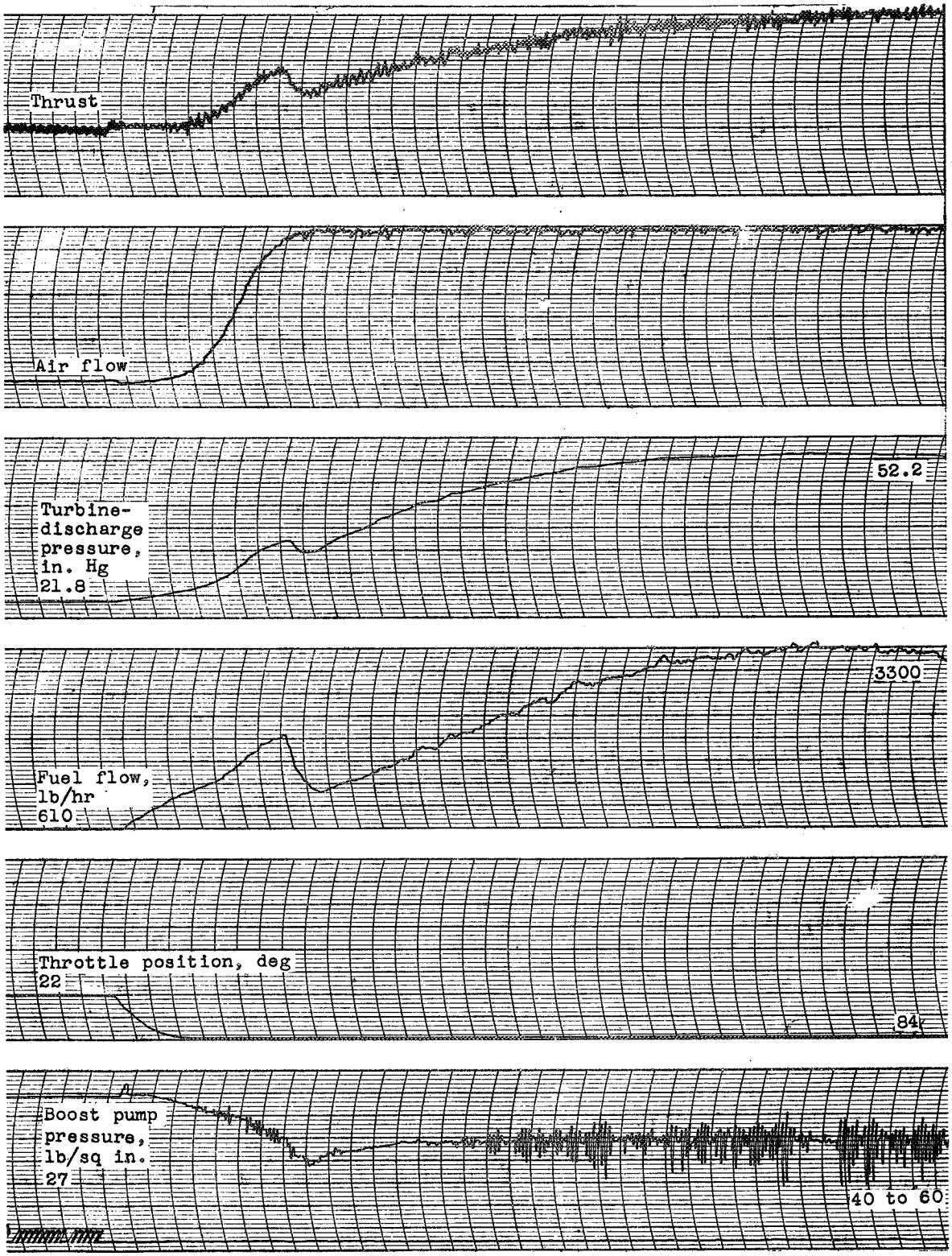


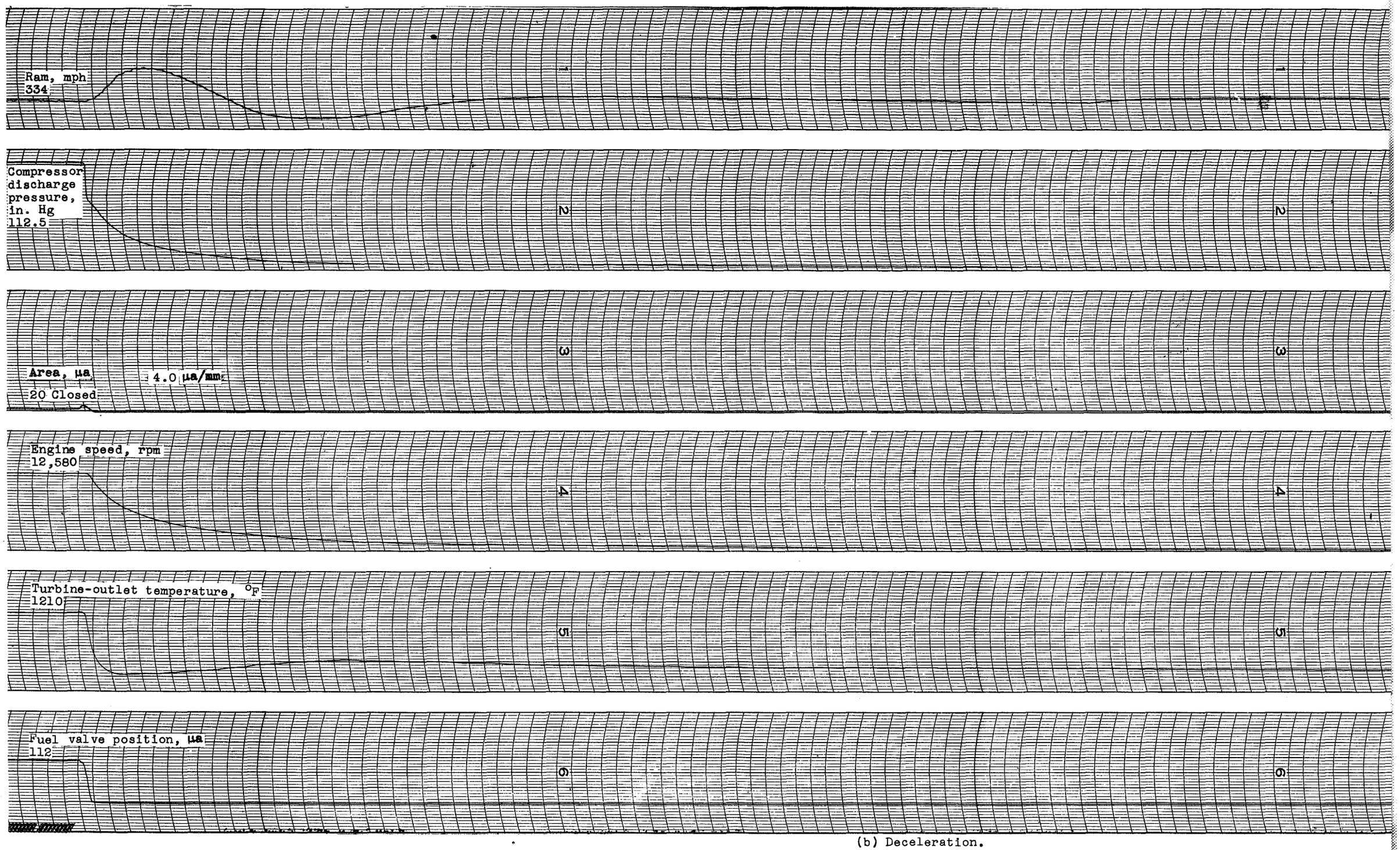
(a) Acceleration.

Figure 13. - Transient operation of automatically-controlled engine. Throttle position, 22° to 84°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



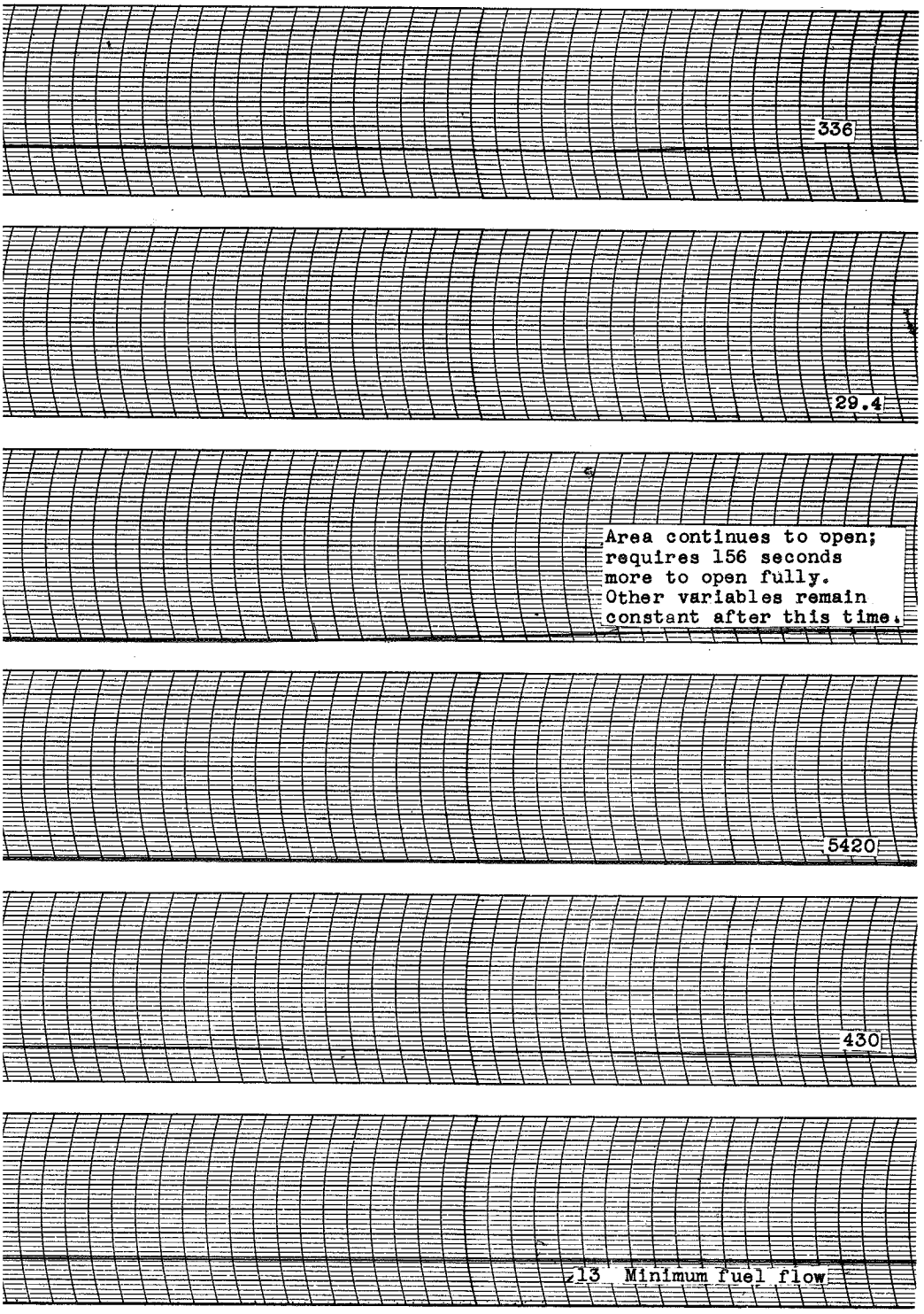
(a) Concluded. - Acceleration.

Figure 13. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 84°; altitude, 10,000 feet; nominal ram-pressure ratio, 1.2.



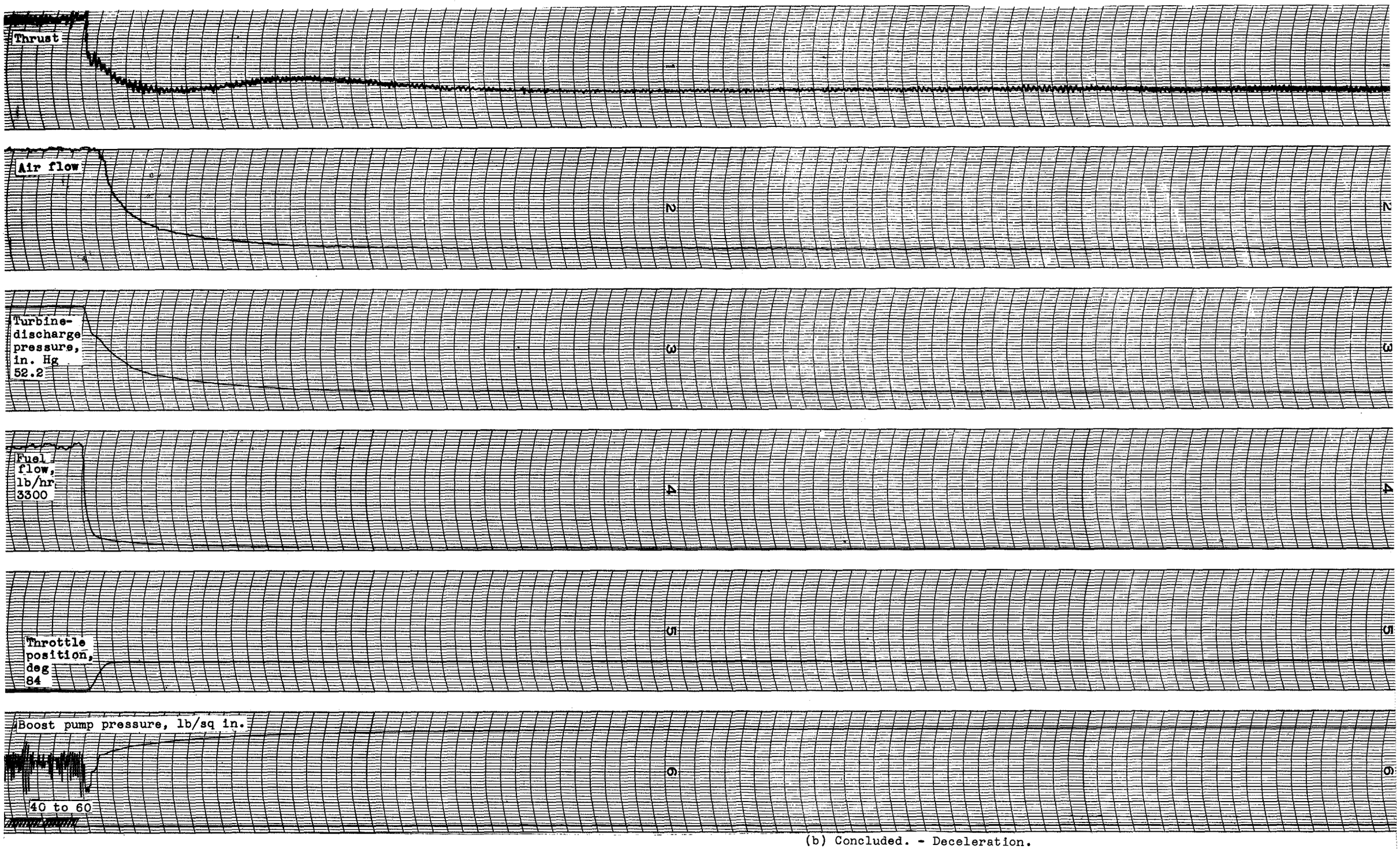
(b) Deceleration.

Figure 13. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 84°; altitude, 10,000 feet; nominal r



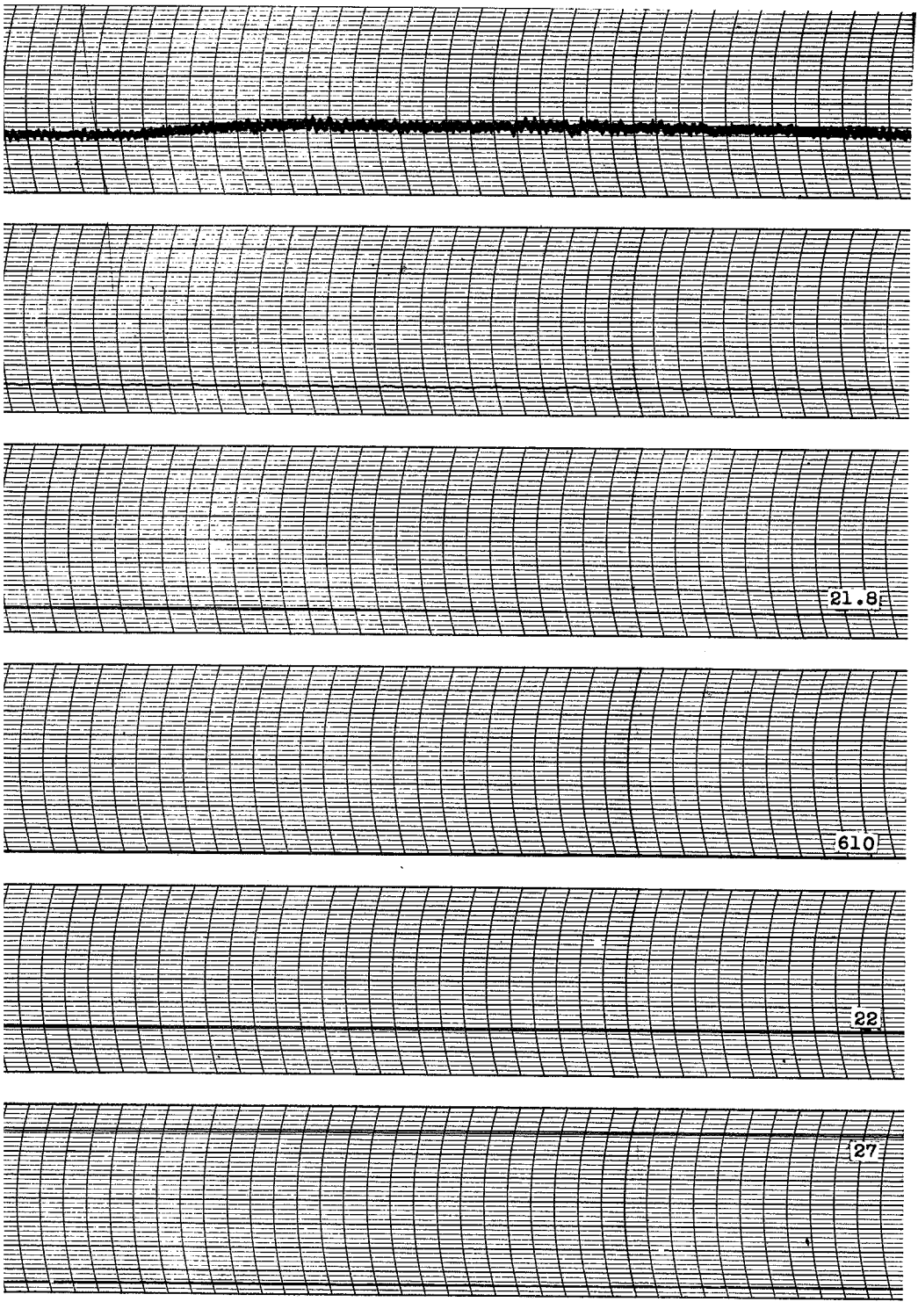
um-pressure ratio, 1.2.

NACA



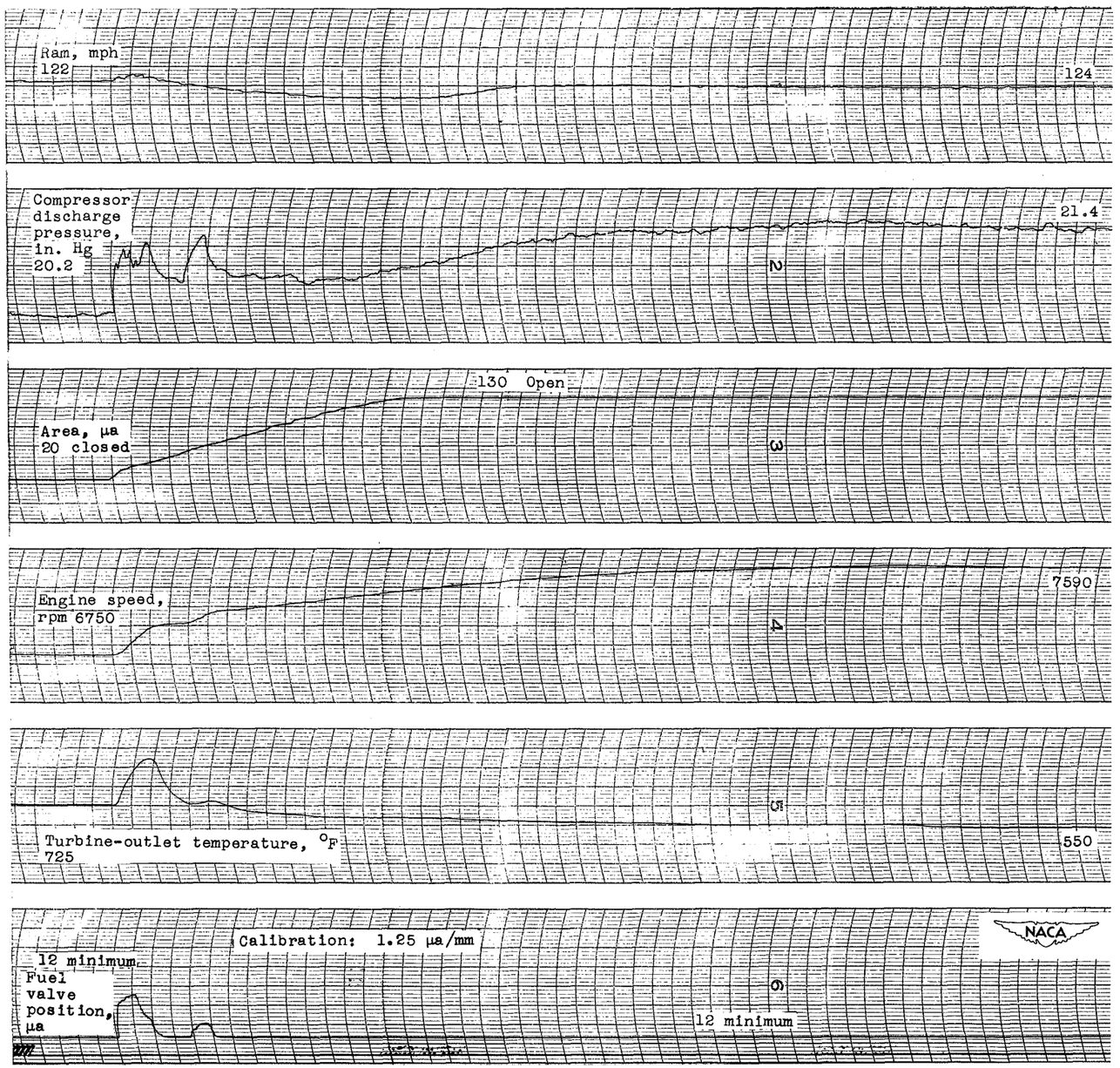
(b) Concluded. - Deceleration.

Figure 13. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22° to 84°; altitude, 10,000 feet; nomina



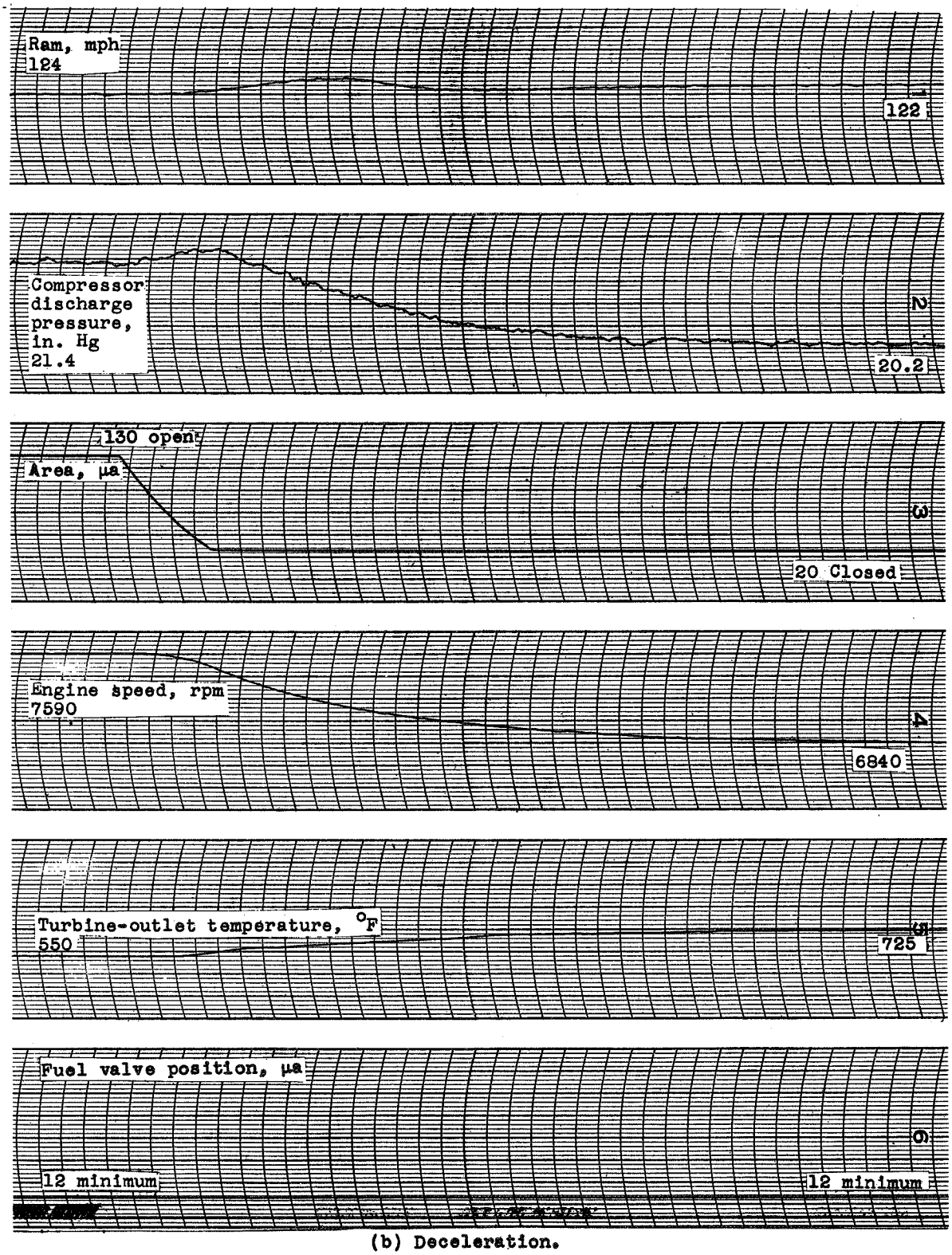
ram-pressure ratio, 1.2.

NACA



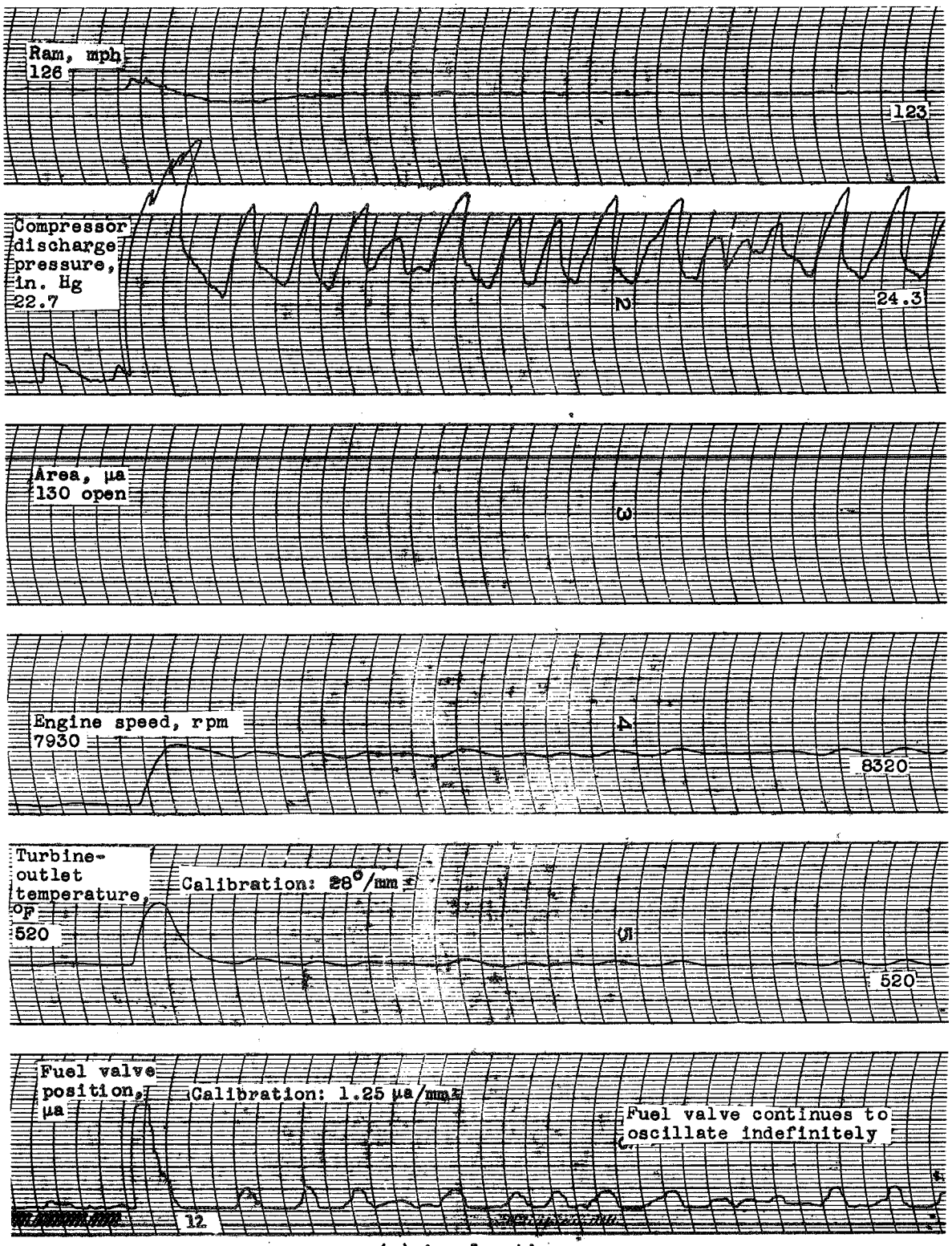
(a) Acceleration

Figure 14. - Transient operation of automatically-controlled engine. Throttle position, 22° to 35°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



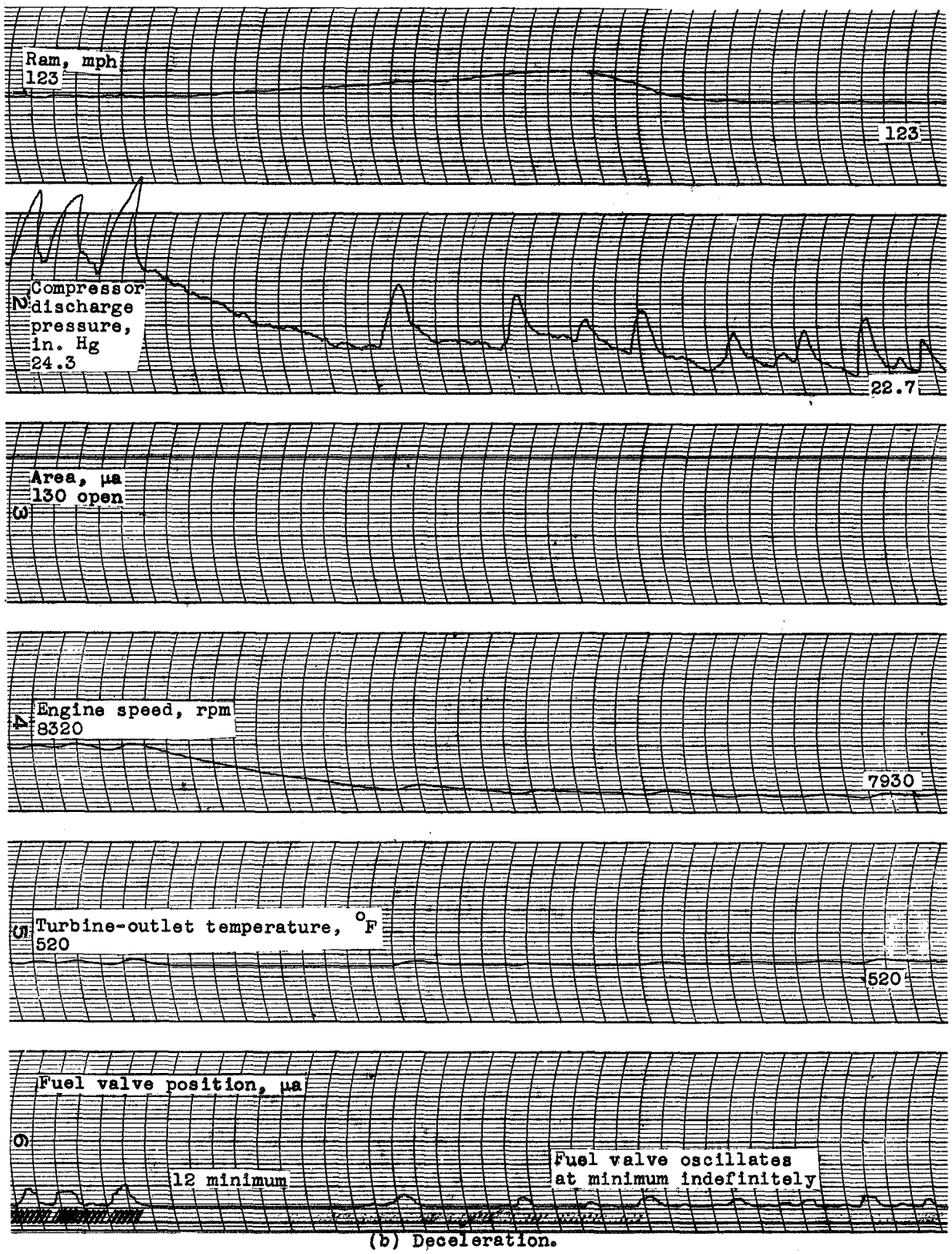
(b) Deceleration.

Figure 14. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 22° to 35°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



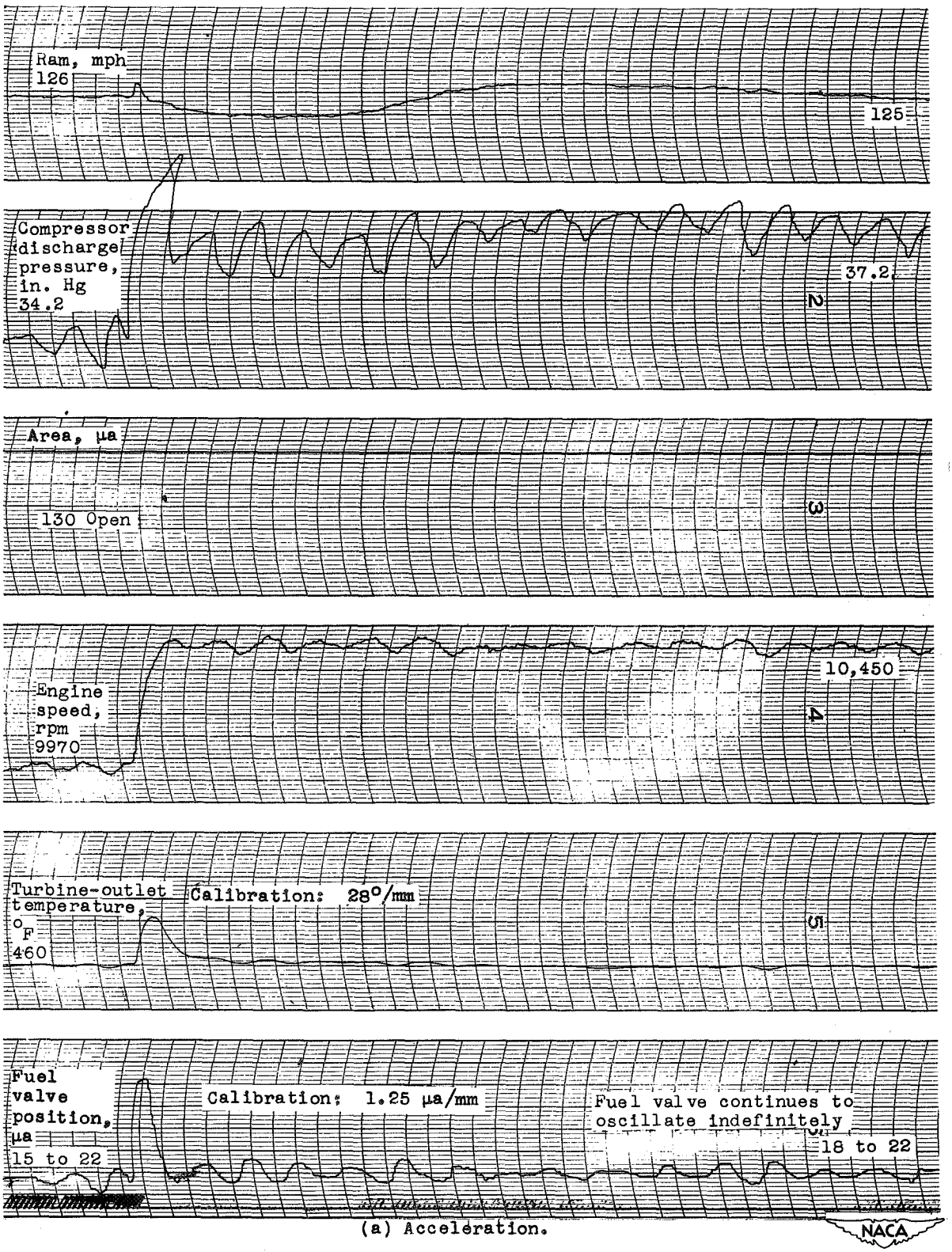
(a) Acceleration.

Figure 15. - Transient operation of automatically-controlled engine. Throttle position, 36.5° to 37.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



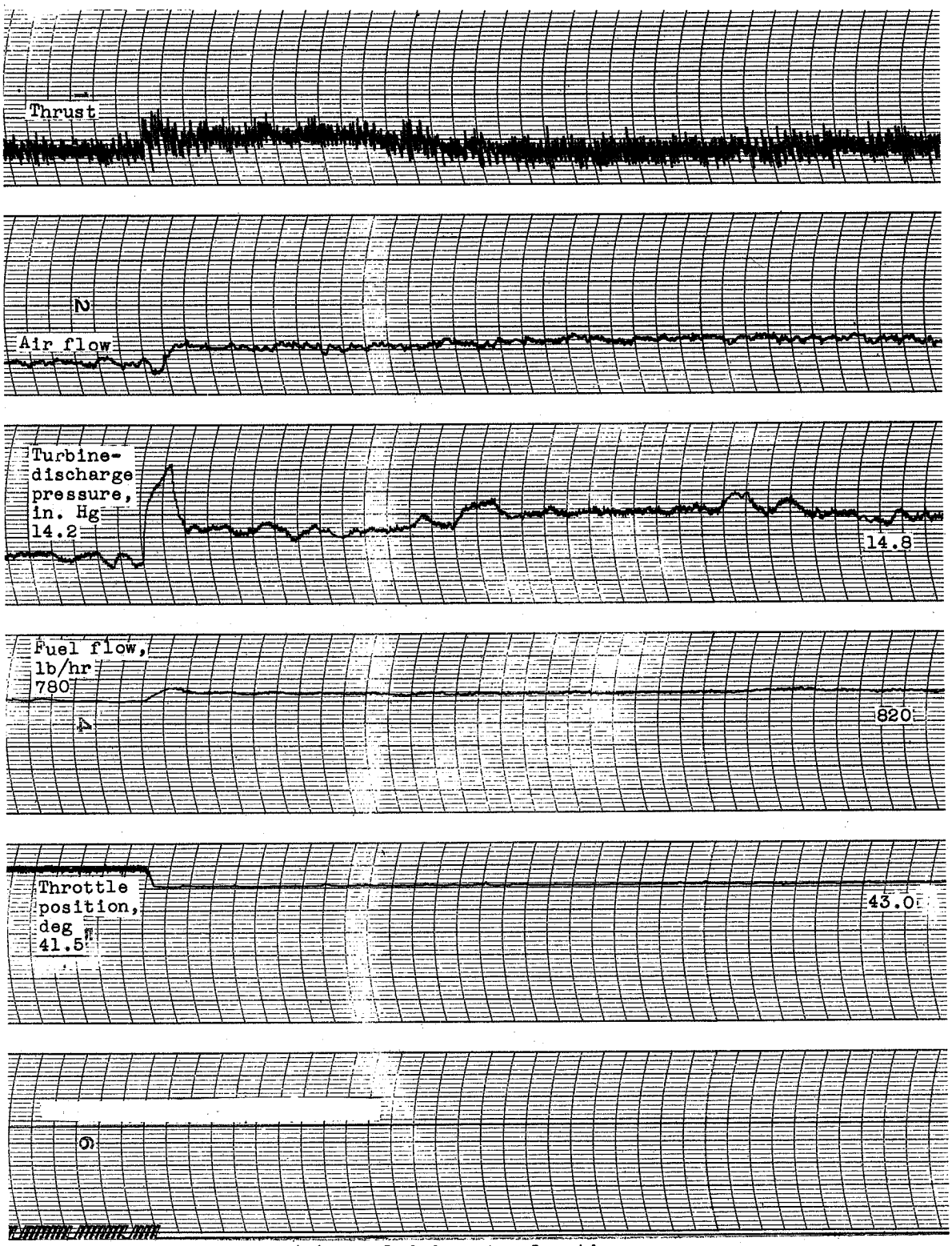
(b) Deceleration.

Figure 15. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 36.5° to 37.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



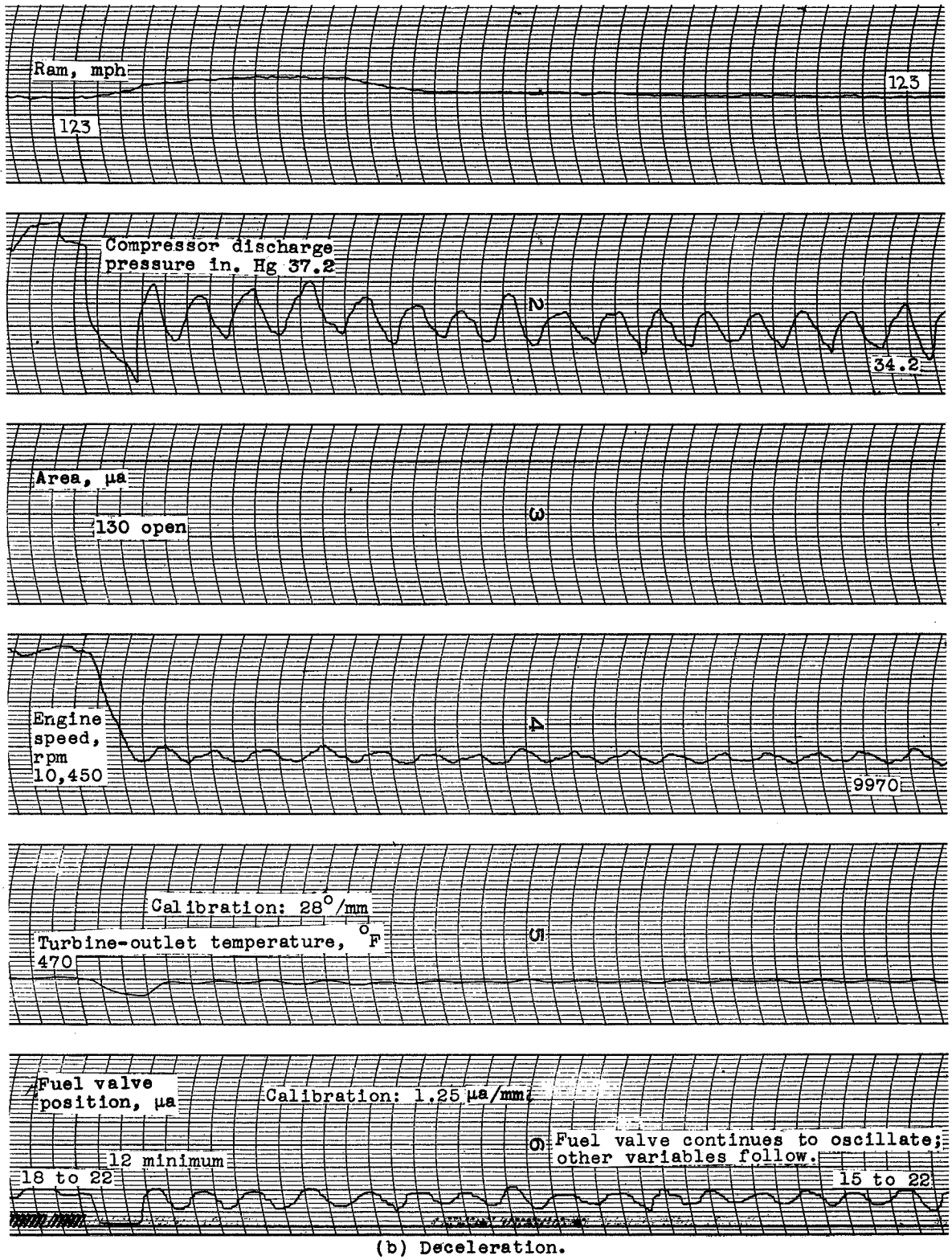
(a) Acceleration.

Figure 16. - Transient operation of automatically-controlled engine. Throttle position, 41.5° to 43°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



(a) Concluded. - Acceleration.

Figure 16. - Continued. Transient operation of automatically-controlled engine. Throttle position, 41.5° to 43°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



(b) Deceleration.

Figure 16. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 41.5° to 43°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

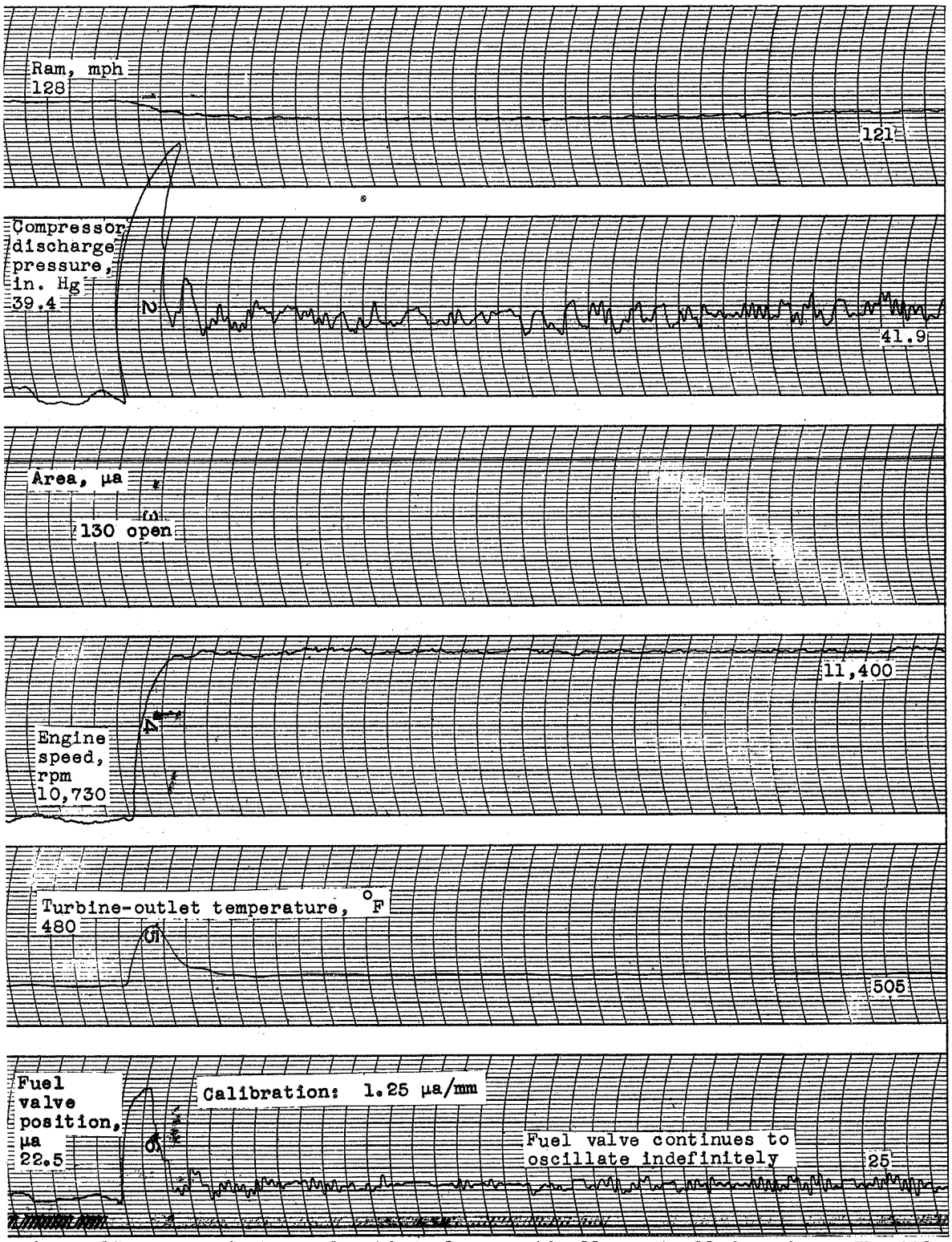


Figure 17. - Transient acceleration of automatically-controlled engine. Throttle position, 42.5° to 54°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

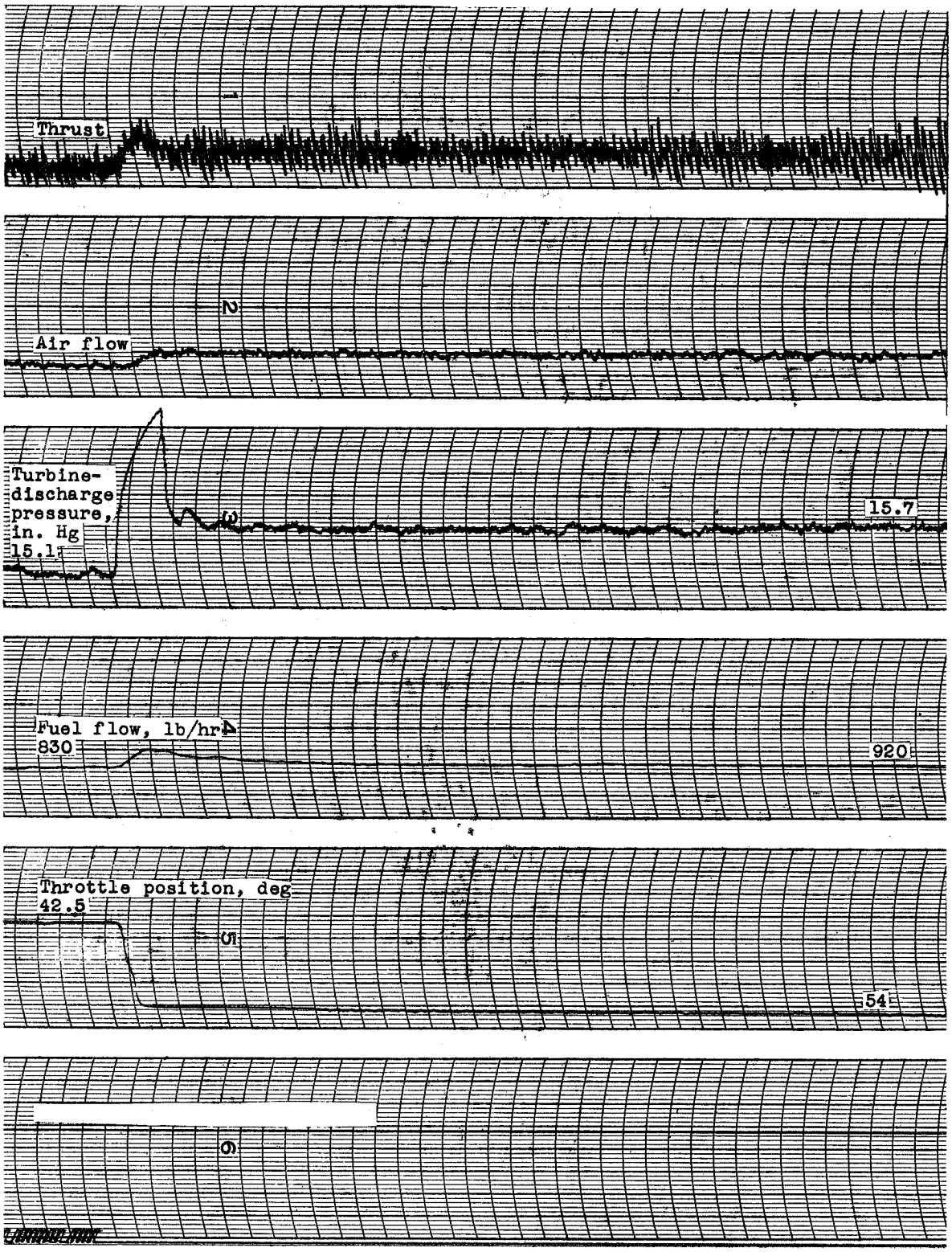


Figure 17. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 42.5° to 54°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

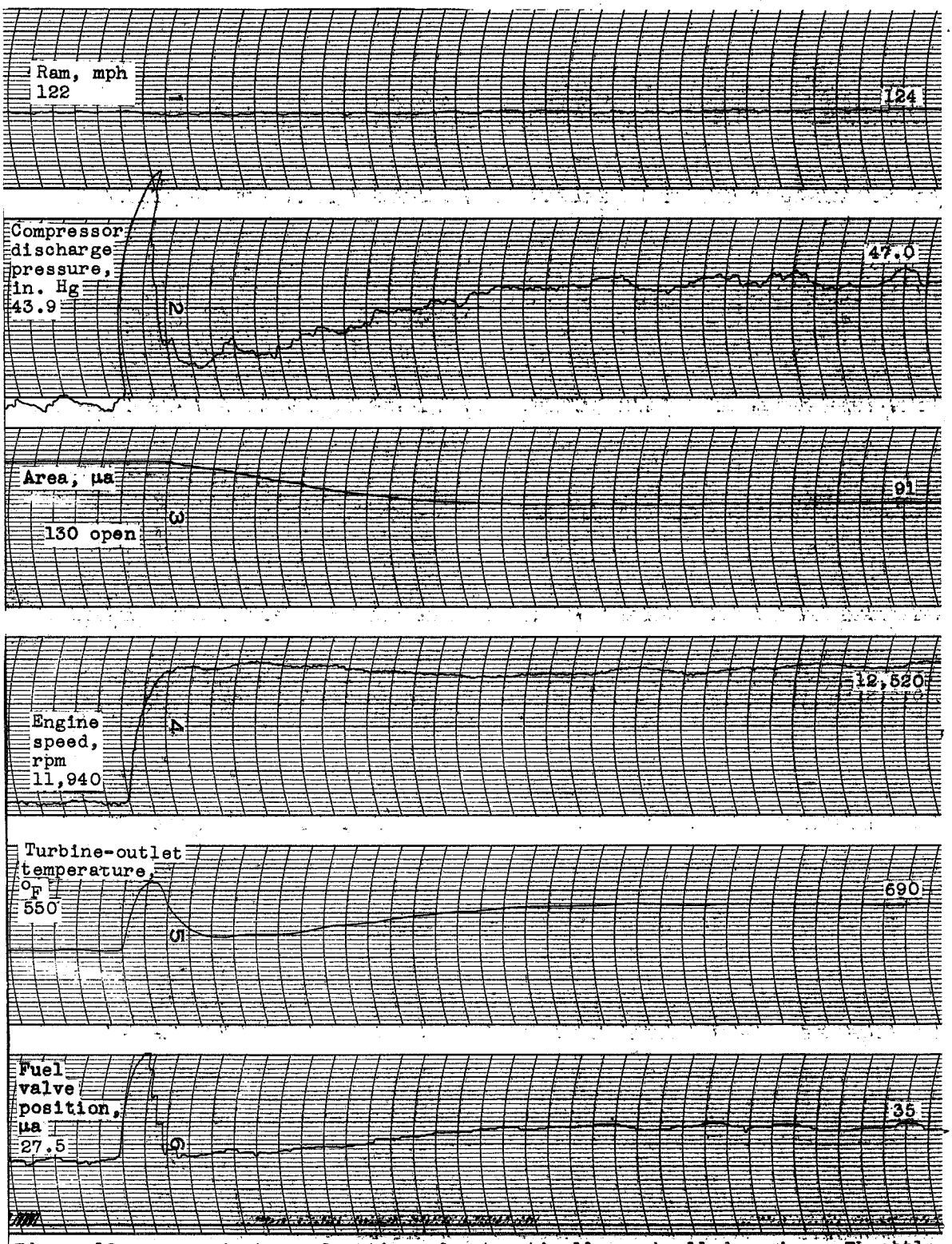


Figure 18. - Transient acceleration of automatically-controlled engine. Throttle position, 62° to 70°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

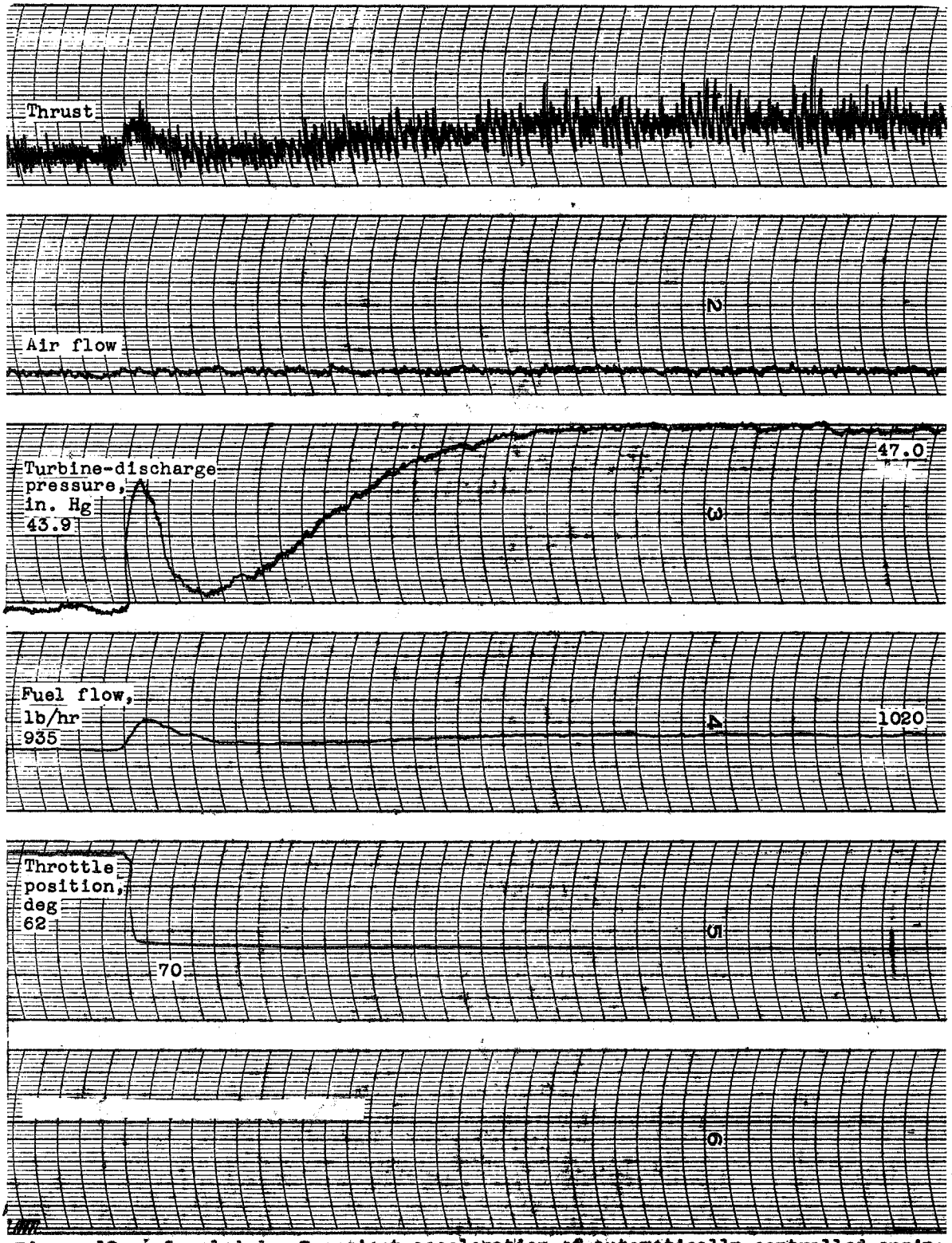
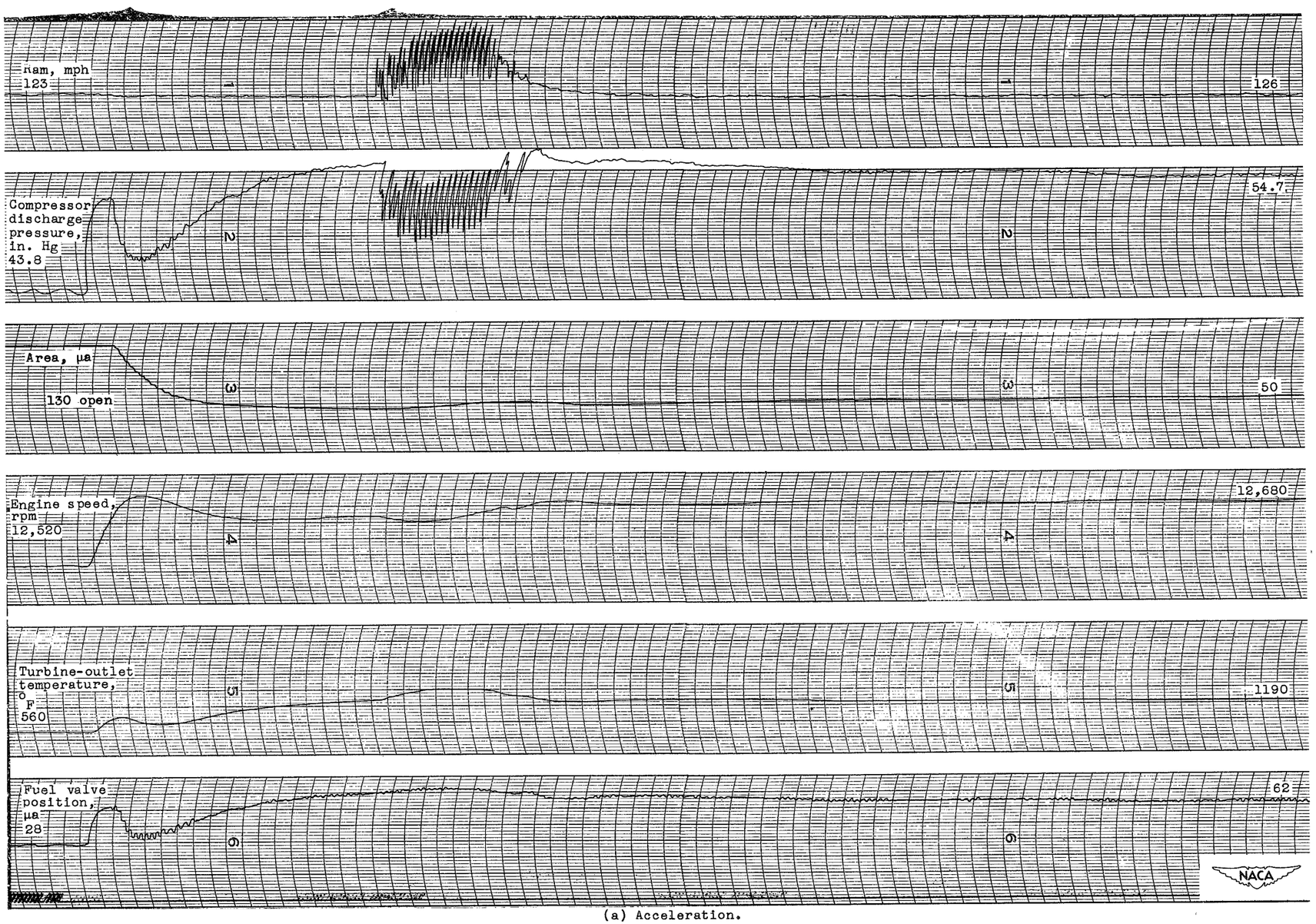
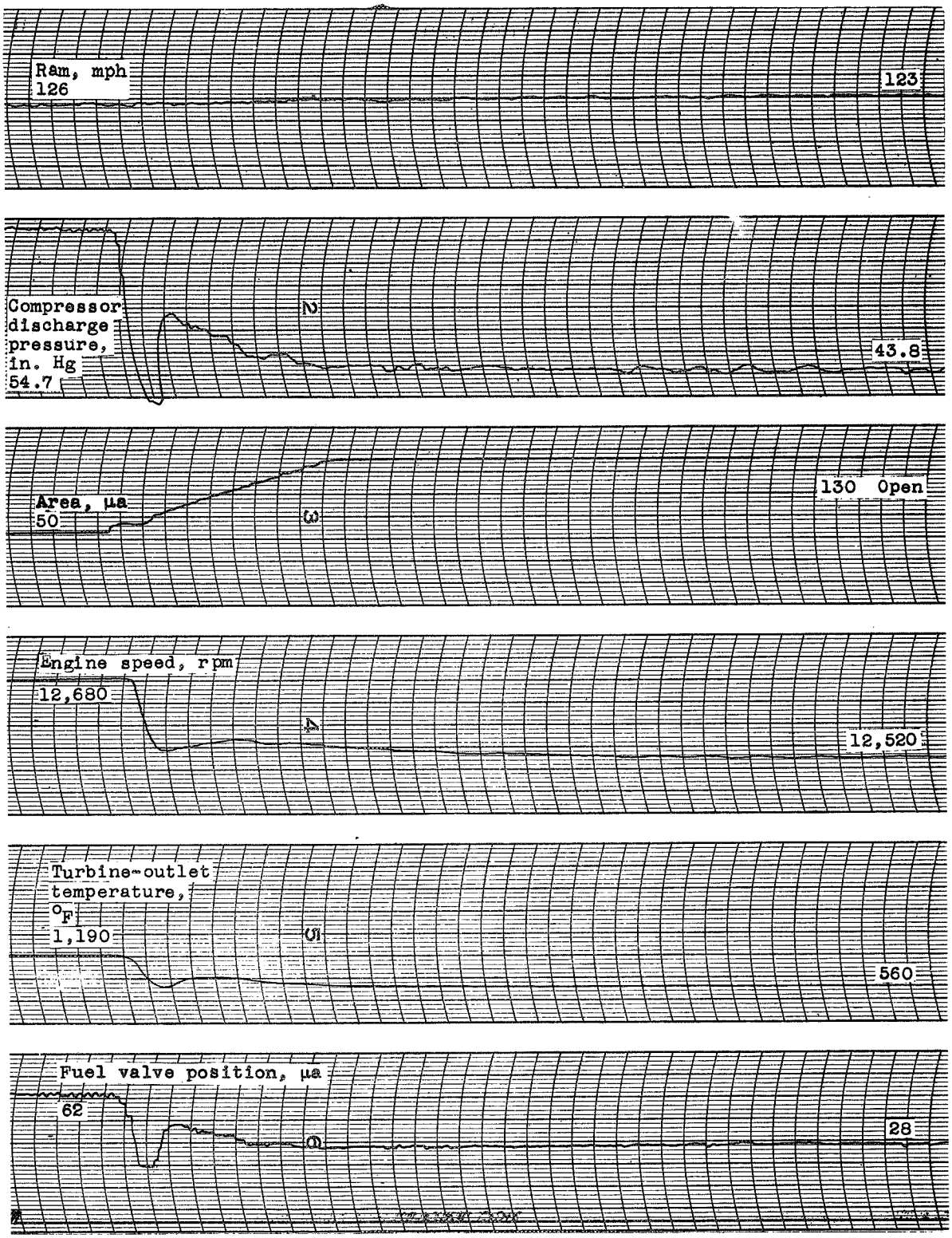


Figure 18. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 62° to 70°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



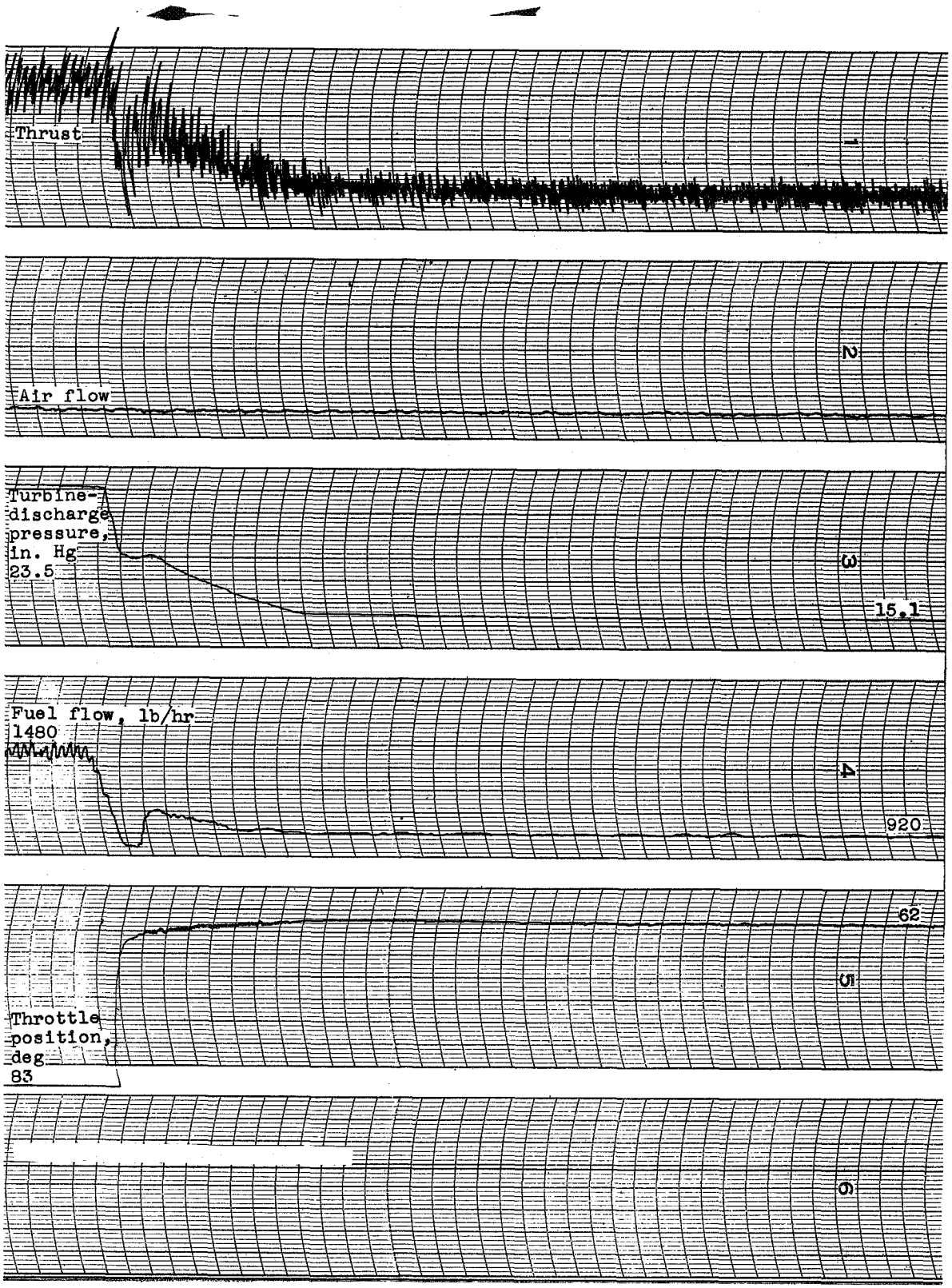
(a) Acceleration.

Figure 19. - Transient operation of automatically-controlled engine. Throttle position, 62° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



(b) Deceleration.

Figure 19. - Continued. Transient operation of automatically-controlled engine. Throttle position, 62° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



(b) Concluded. - Deceleration

Figure 19. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 62° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

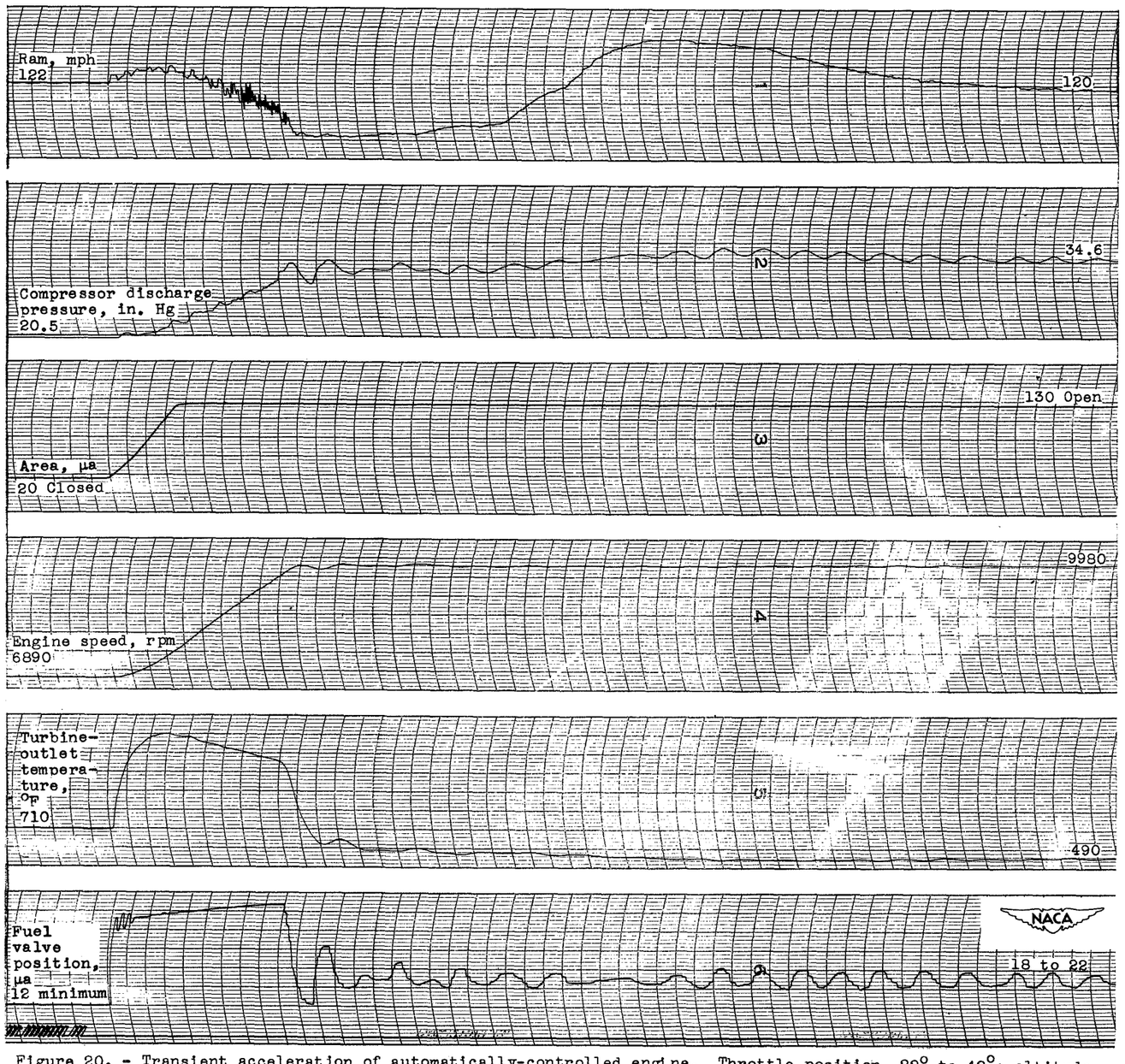


Figure 20. - Transient acceleration of automatically-controlled engine. Throttle position, 22° to 42°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

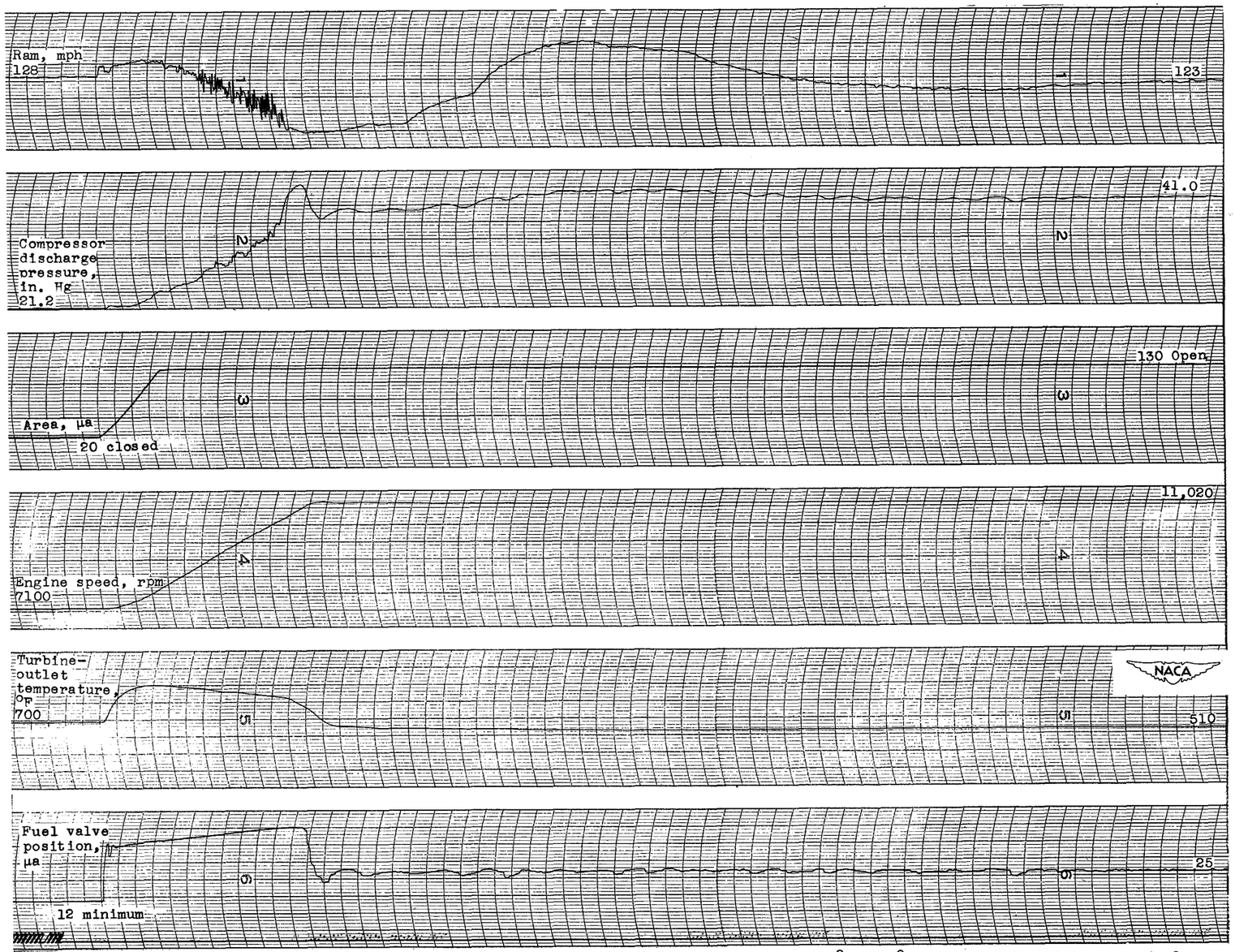


Figure 21. - Transient acceleration of automatically-controlled engine. Throttle position, 22° to 52°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

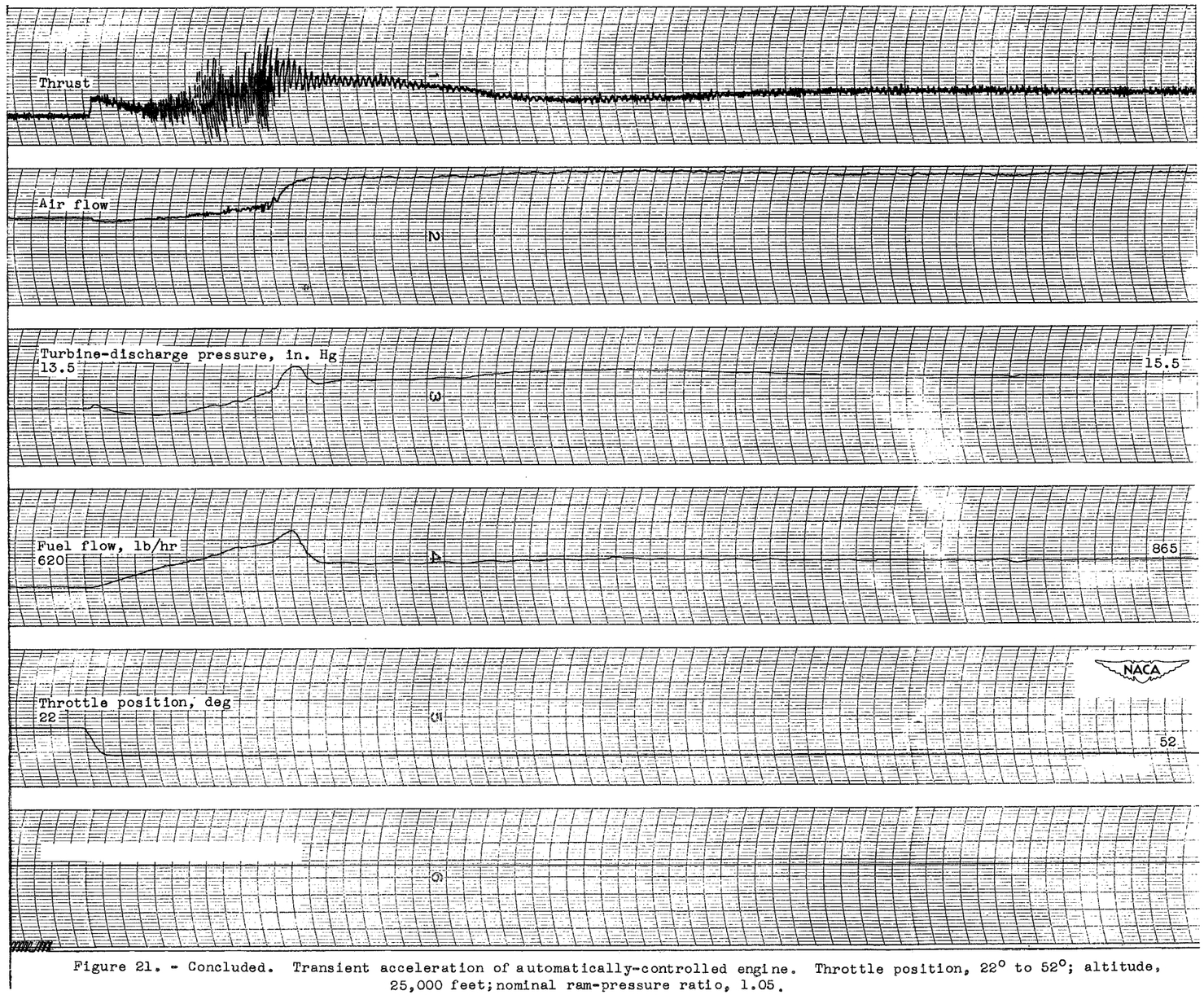


Figure 21. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 22° to 52°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

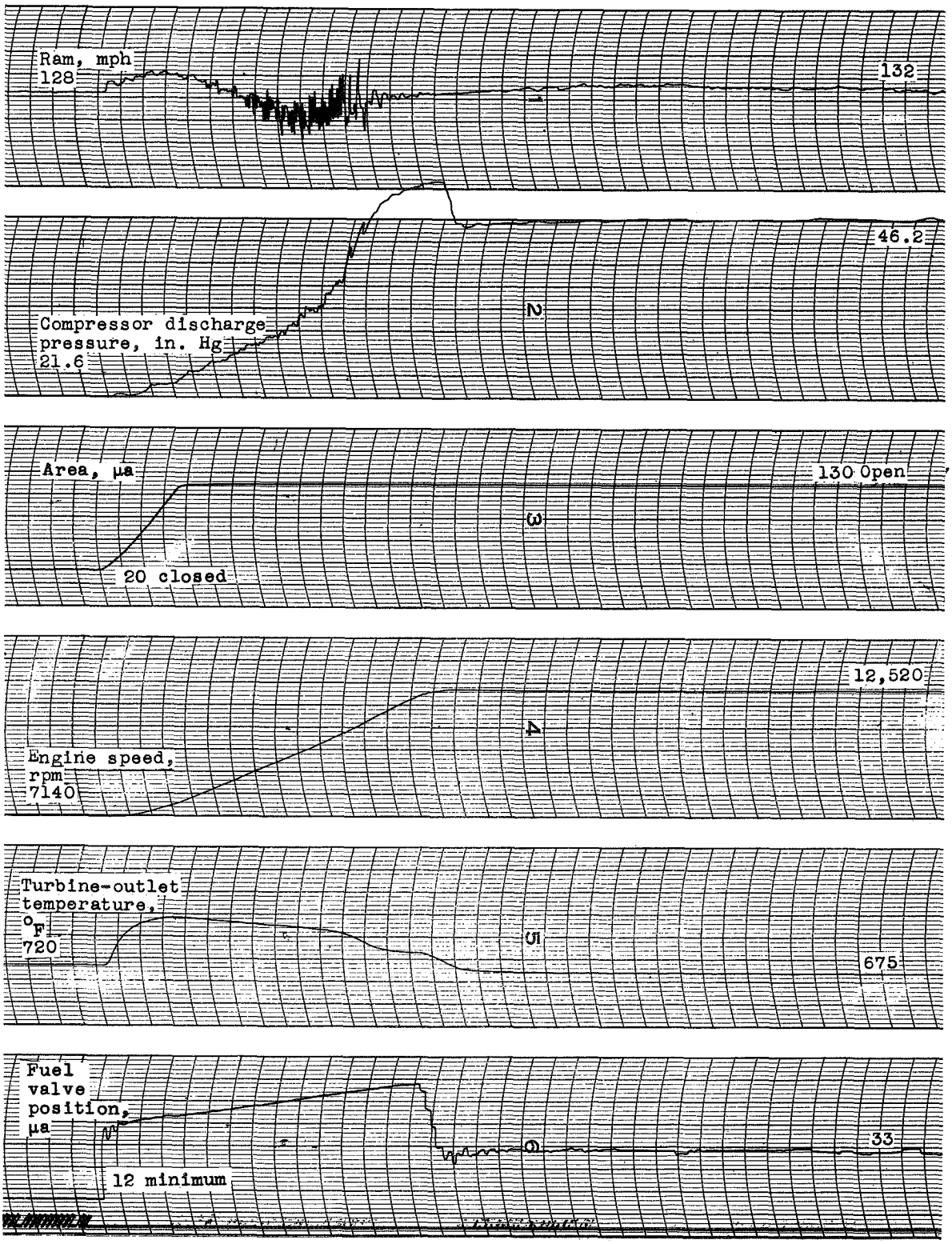


Figure 22. Transient acceleration of automatically-controlled engine. Throttle position. 22.5° to 70°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

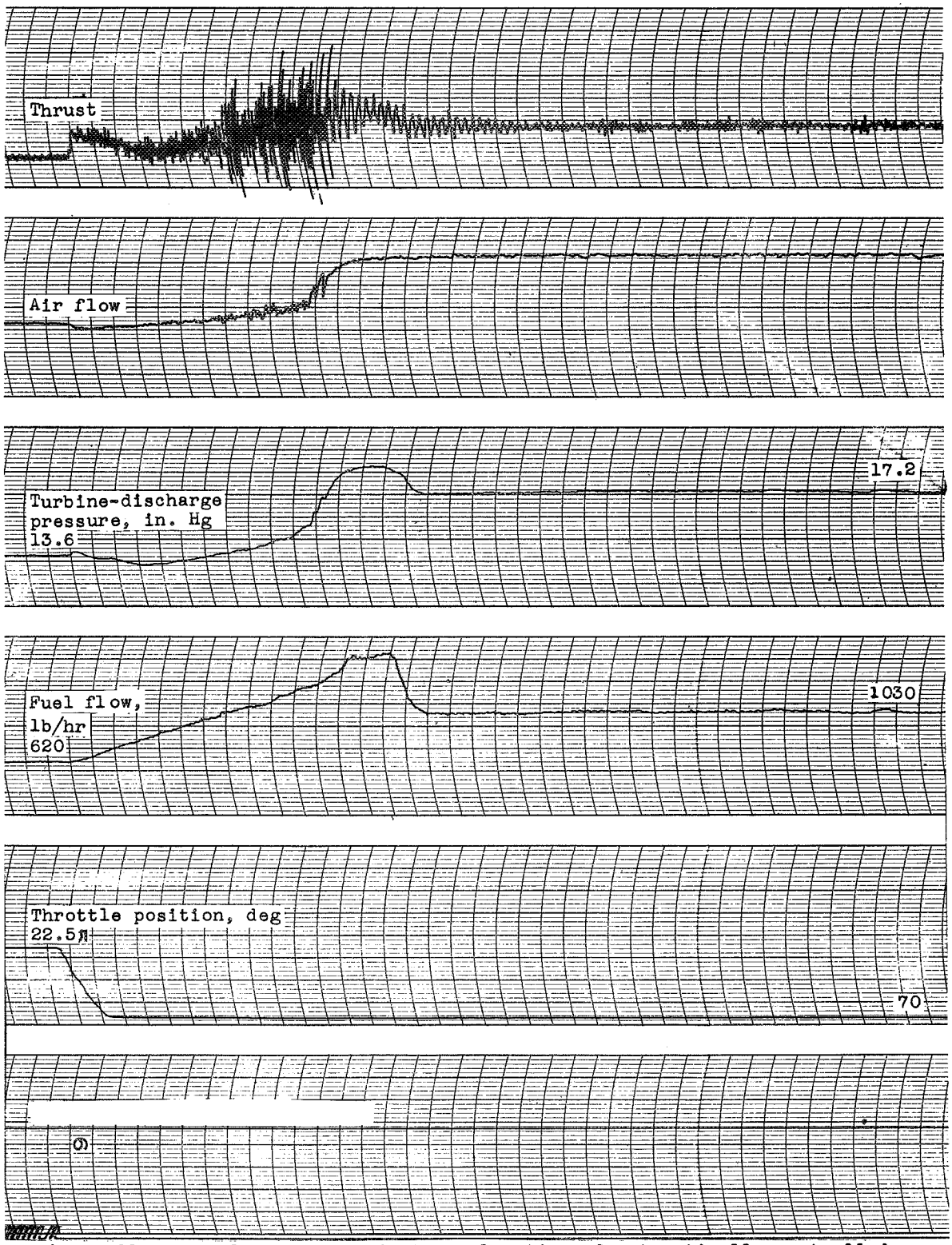
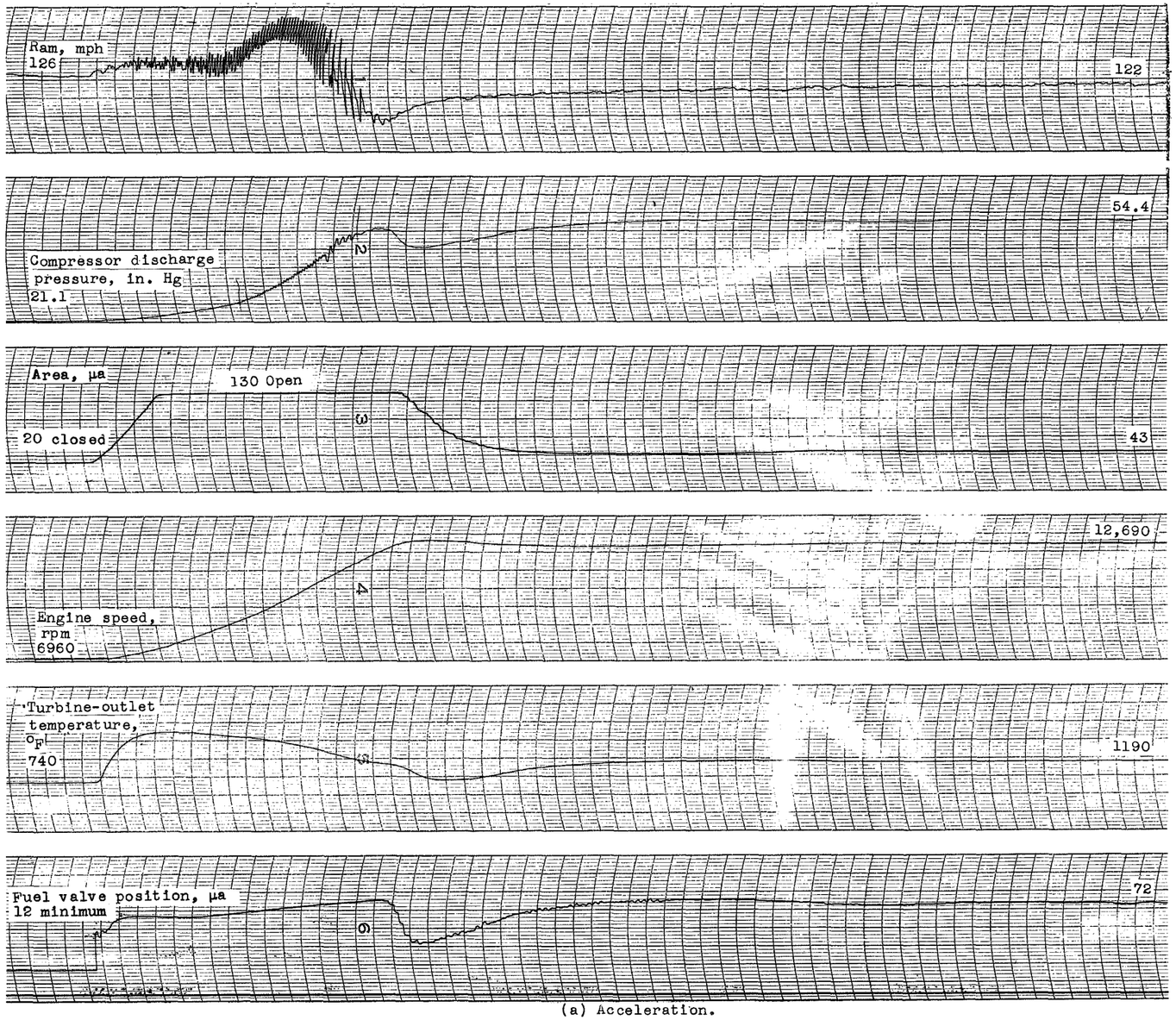
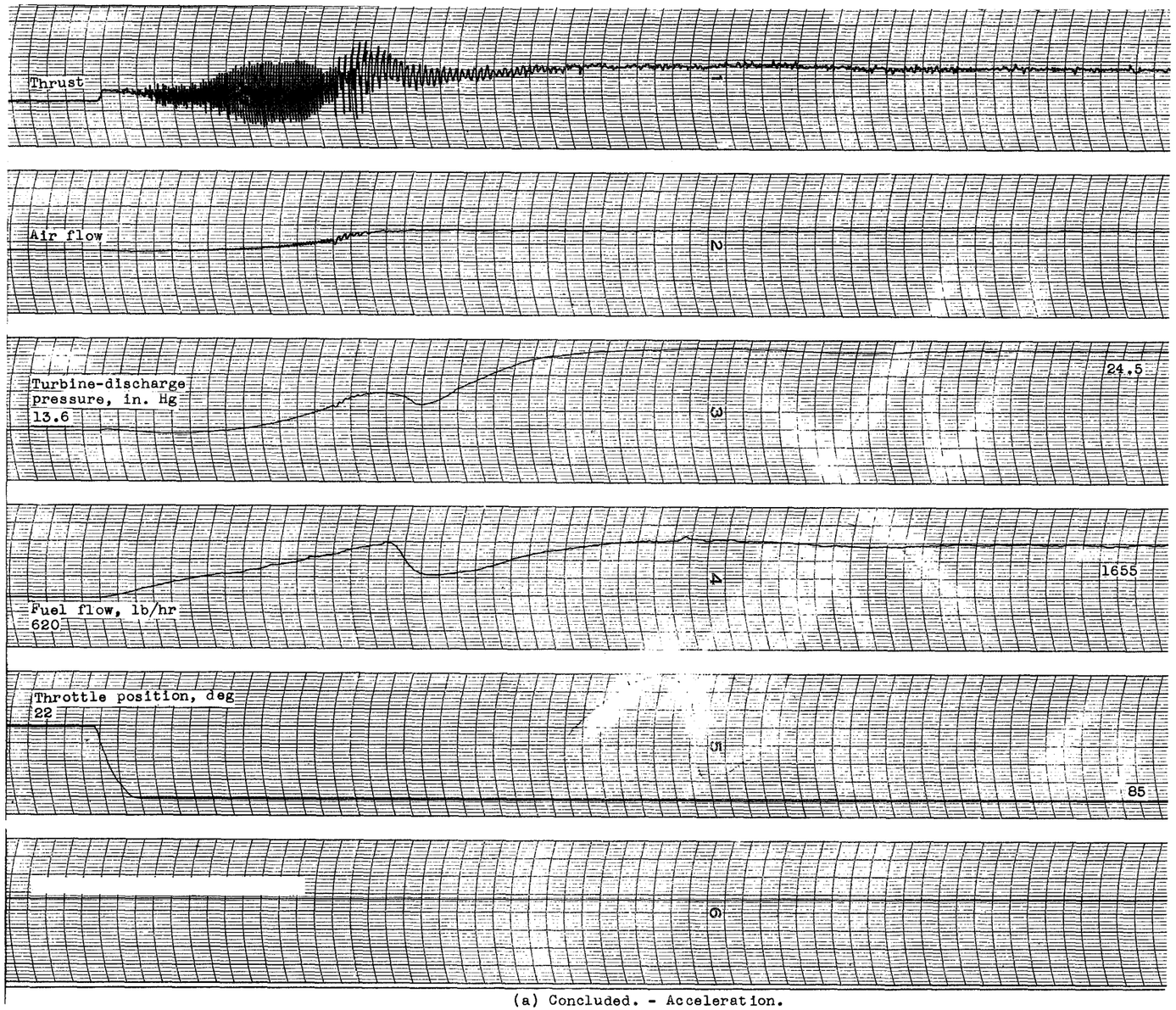


Figure 22. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 22.5° to 70°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



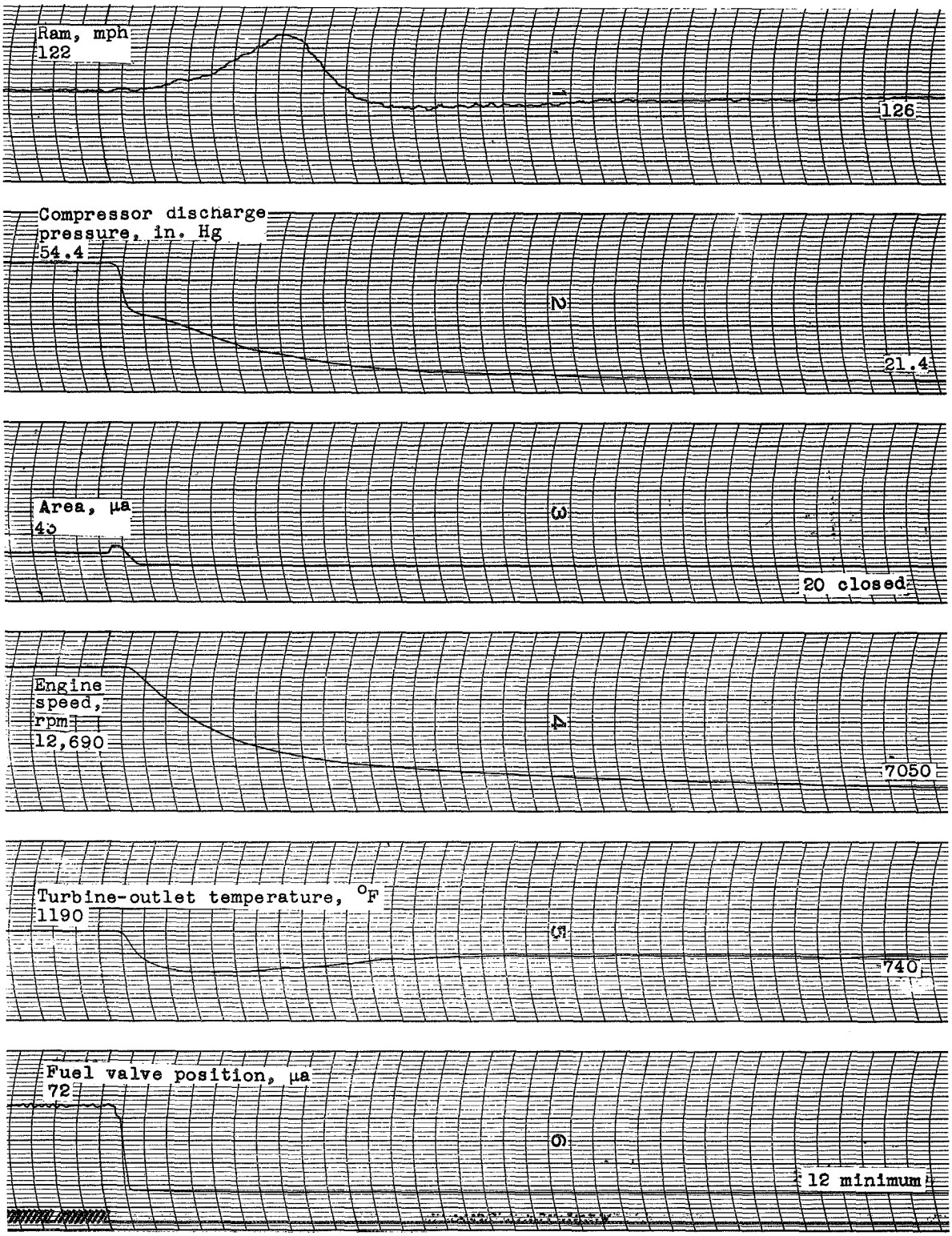
(a) Acceleration.

Figure 23. - Transient operation of automatically-controlled engine. Throttle position, 22° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



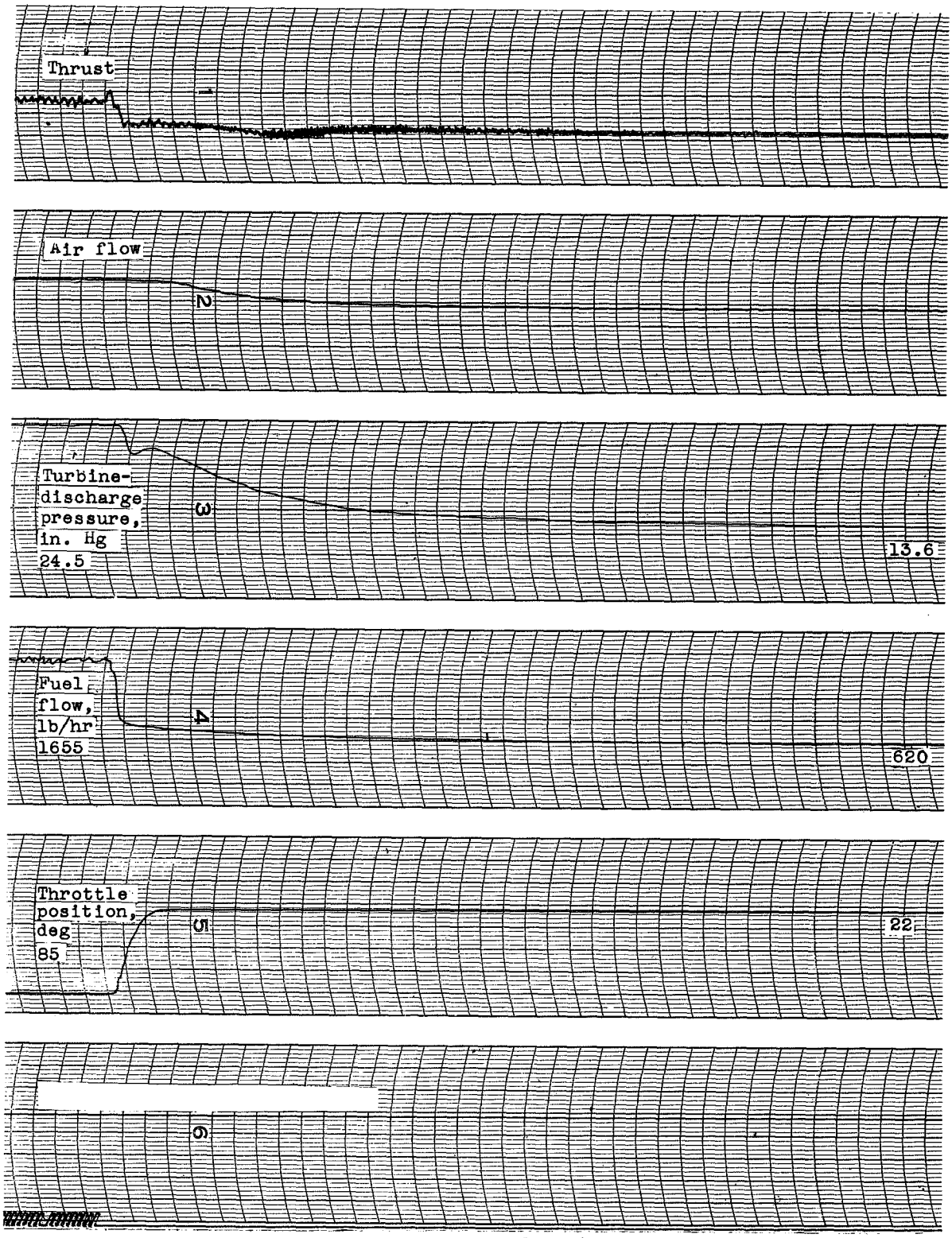
(a) Concluded. - Acceleration.

Figure 23. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.



(b) Deceleration

Figure 23. - Continued. Transient operation of automatically-controlled engine. Throttle position, 22° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05



(b) Concluded. - Deceleration

Figure 23. - Concluded. Transient operation of automatically-controlled engine. Throttle position 22 to 85 ; altitude, 25,000 feet; nominal ram-pressure ratio, 1.05.

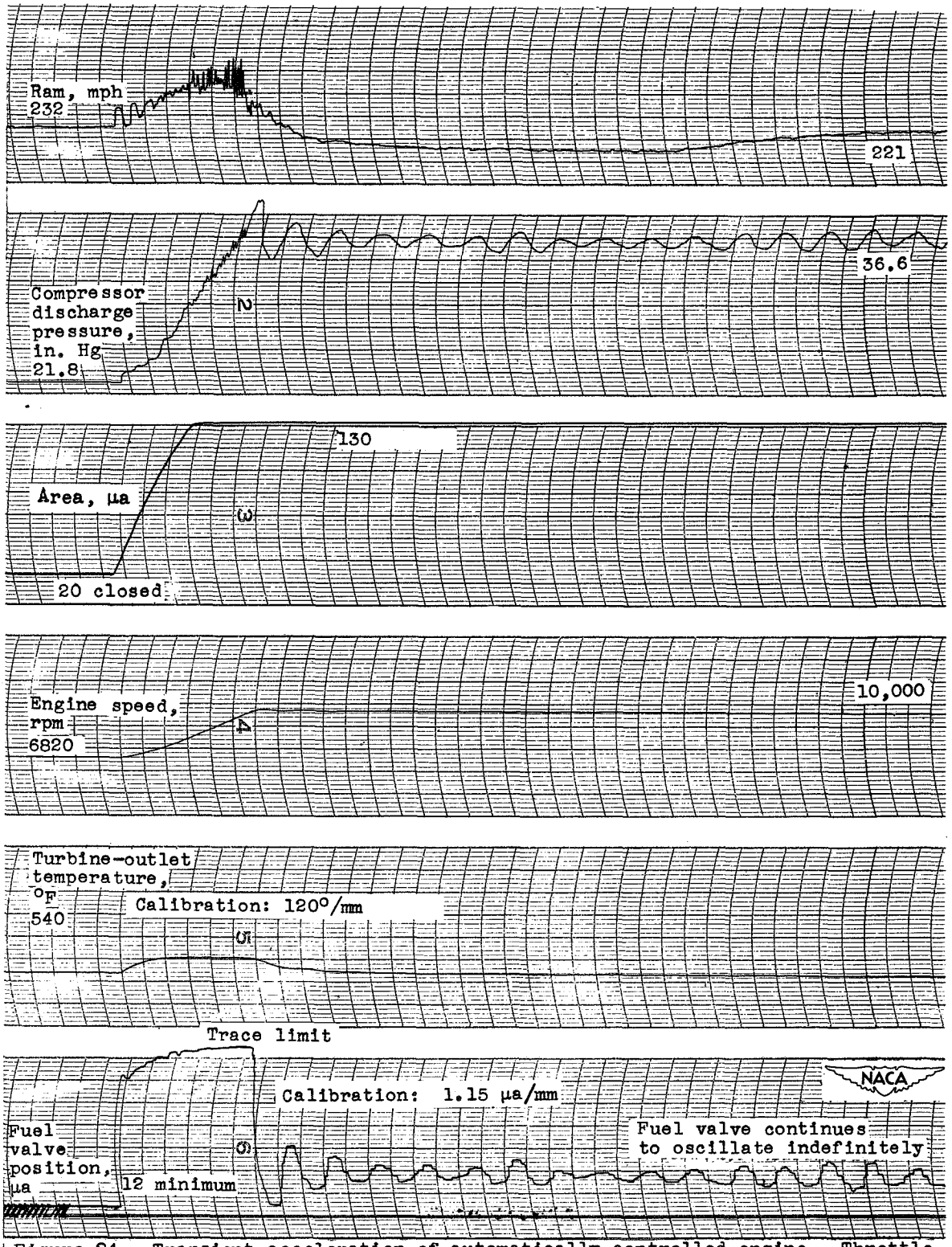
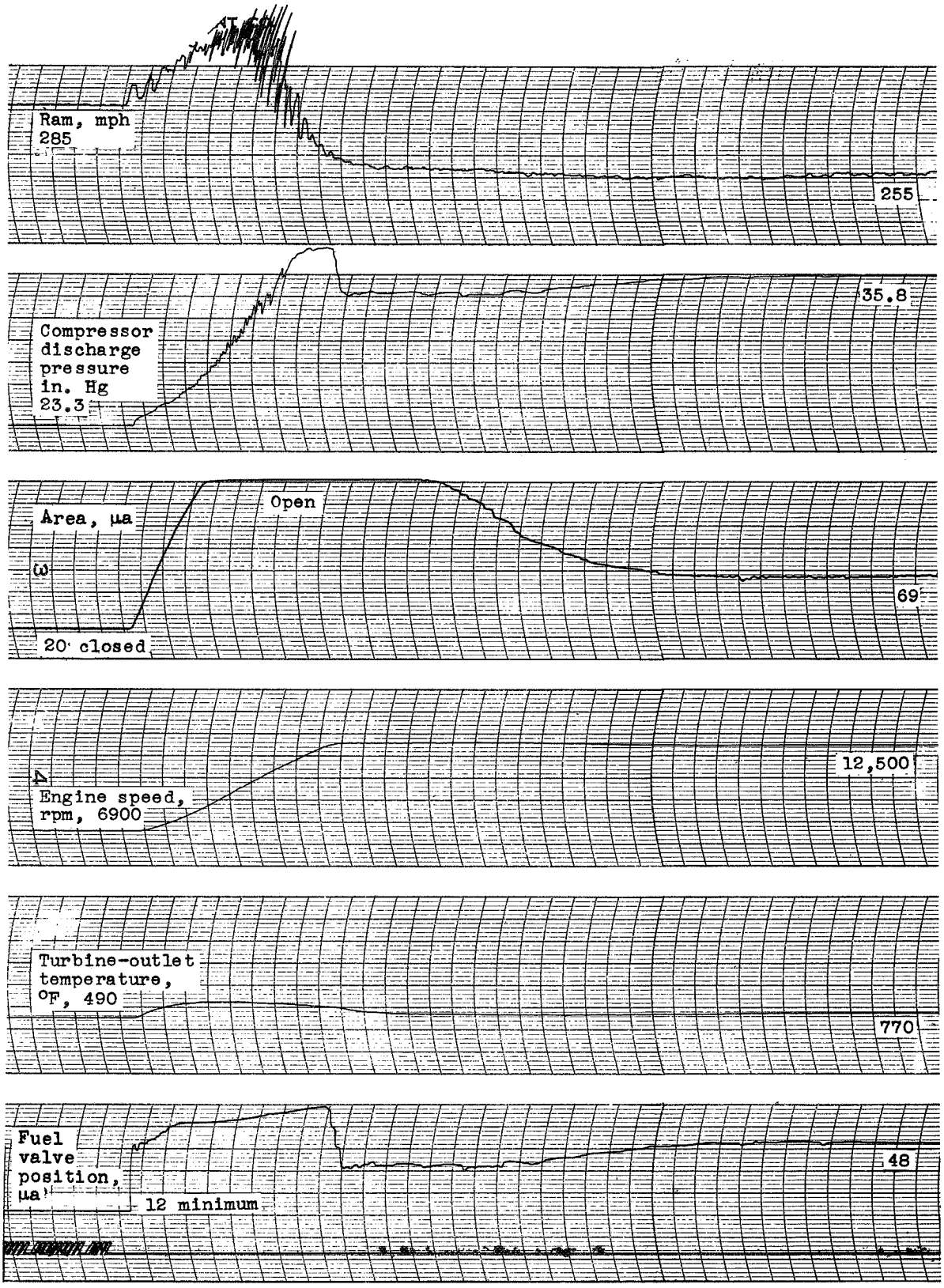
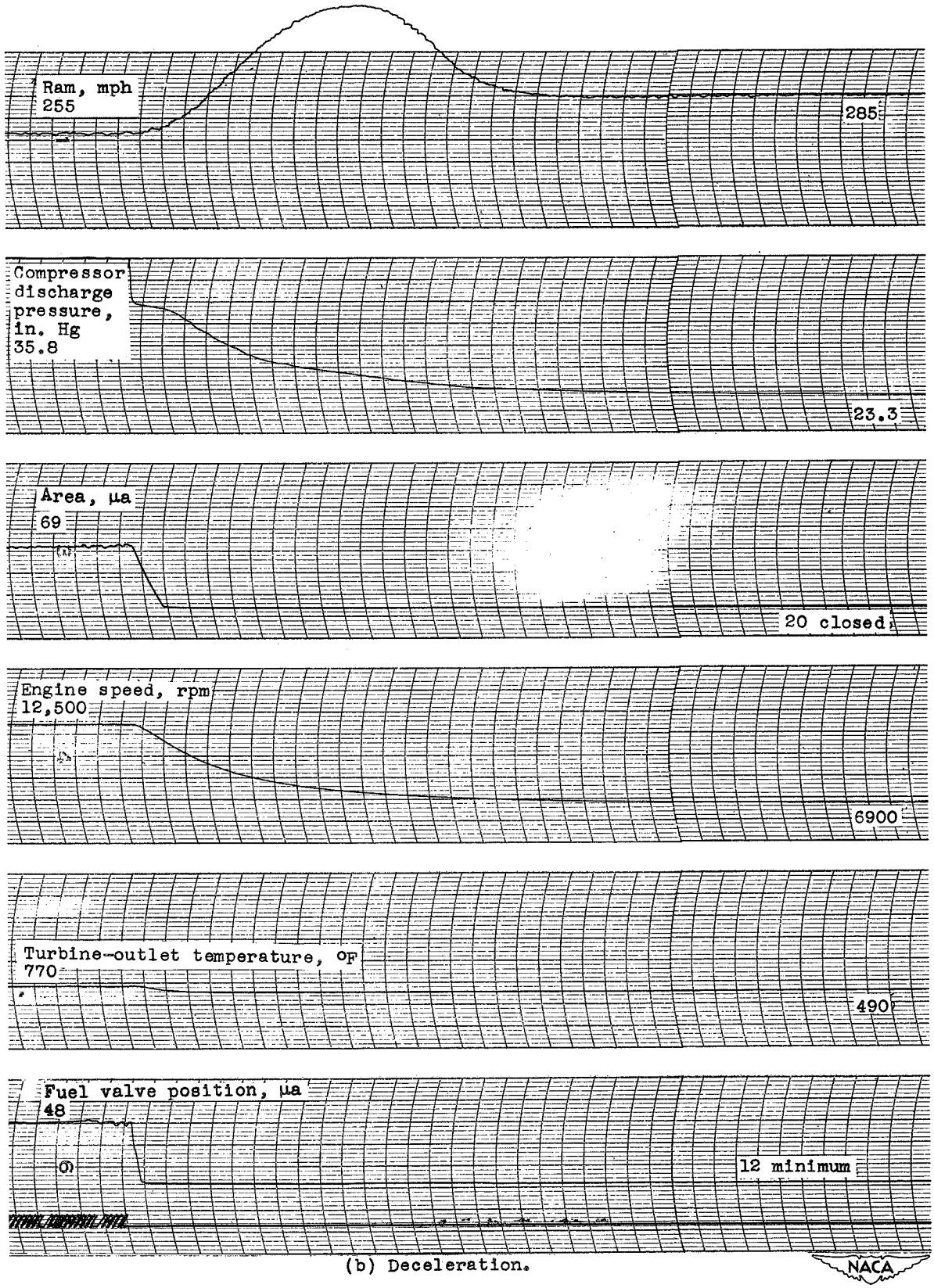


Figure 24. Transient acceleration of automatically-controlled engine. Throttle position, 22° to 42°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



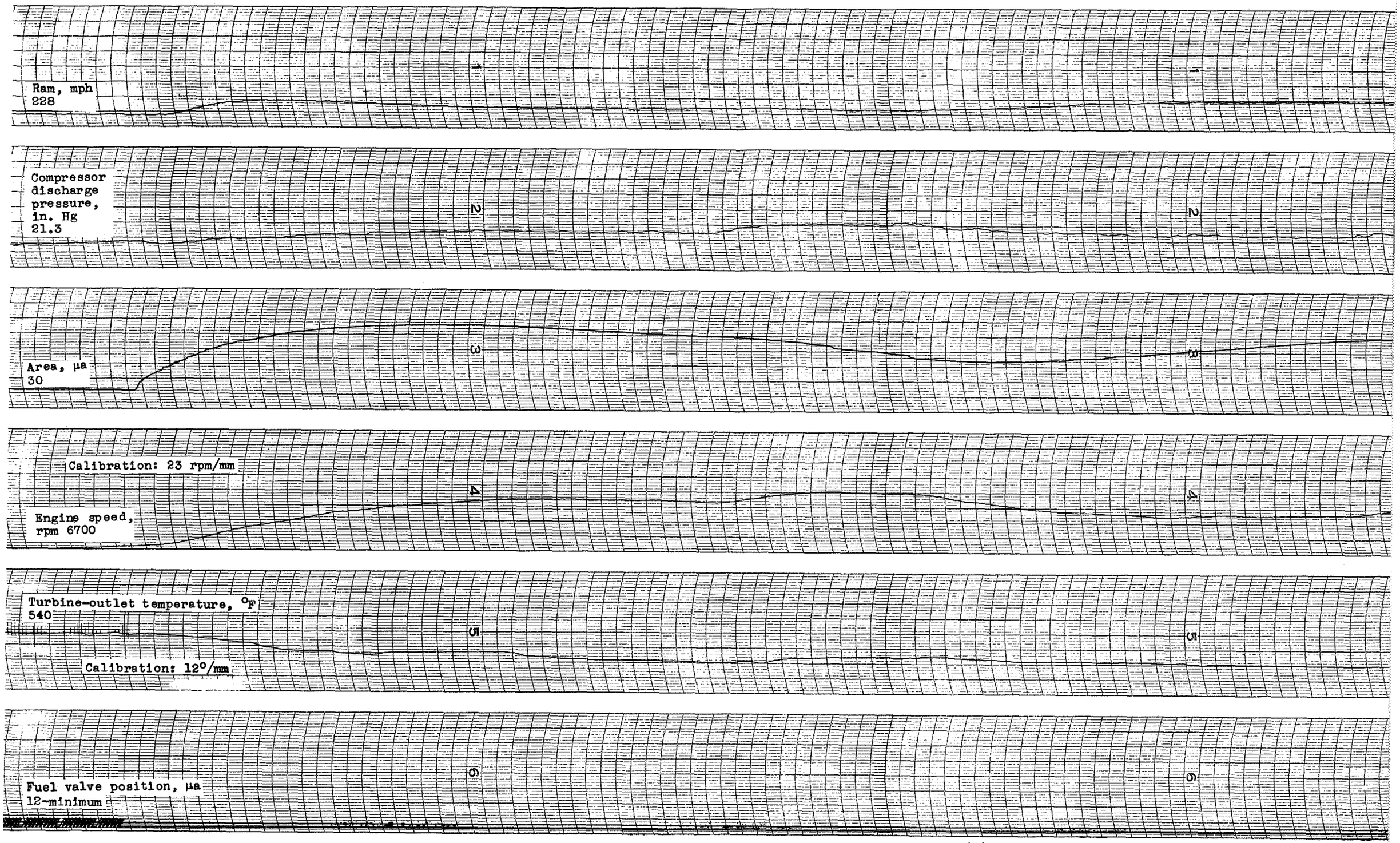
(a) Acceleration.

Figure 25. - Transient operation of automatically-controlled engine. Throttle position, 26° to 72°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2



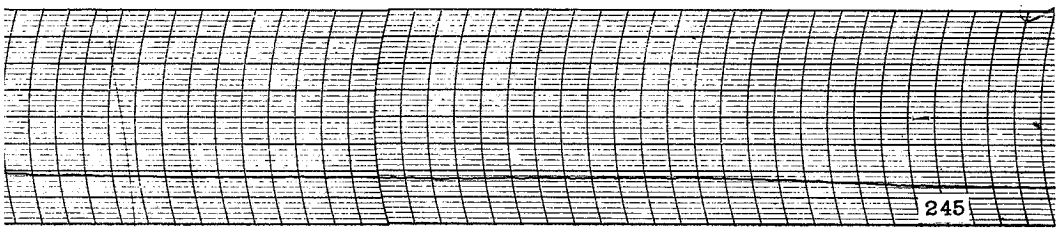
(b) Deceleration.

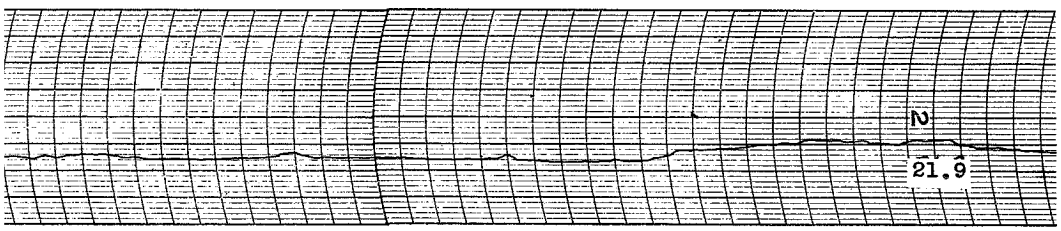
Figure 25. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 72° to 26°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2 .

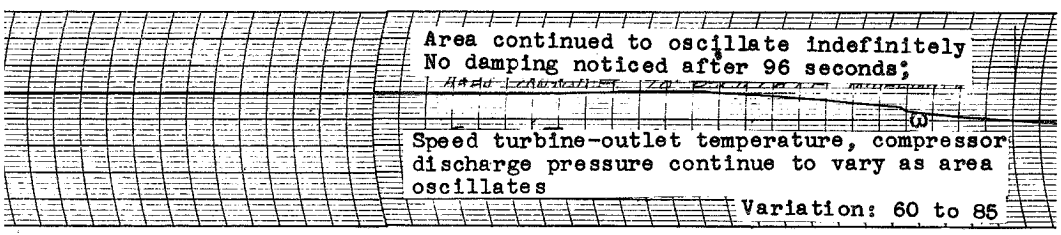


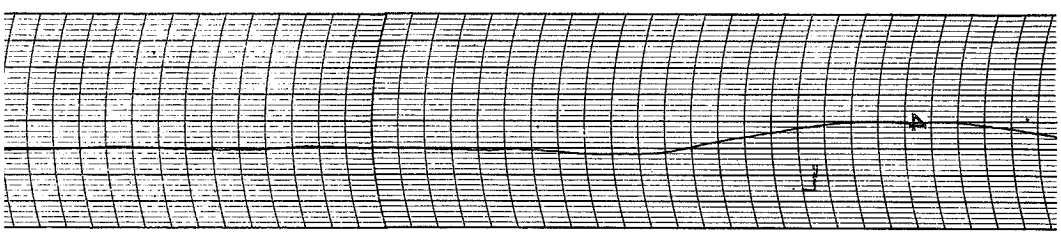
(a) Acceleration.

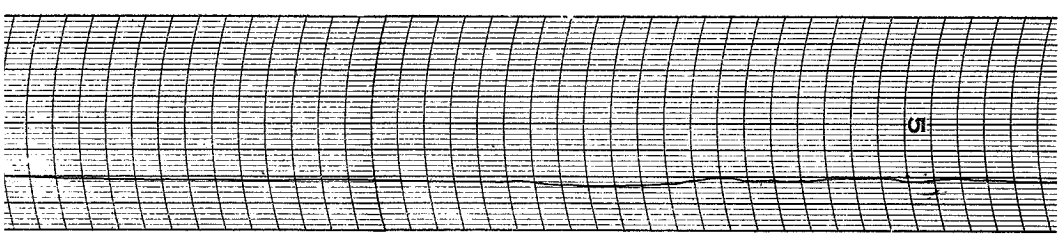
Figure 26. Transient operation of automatically-controlled engine. Throttle position, 31.5° to 33.5°; altitude, 25,000 feet; nc

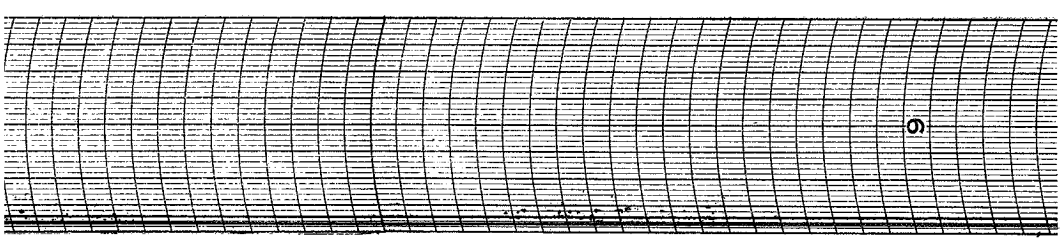




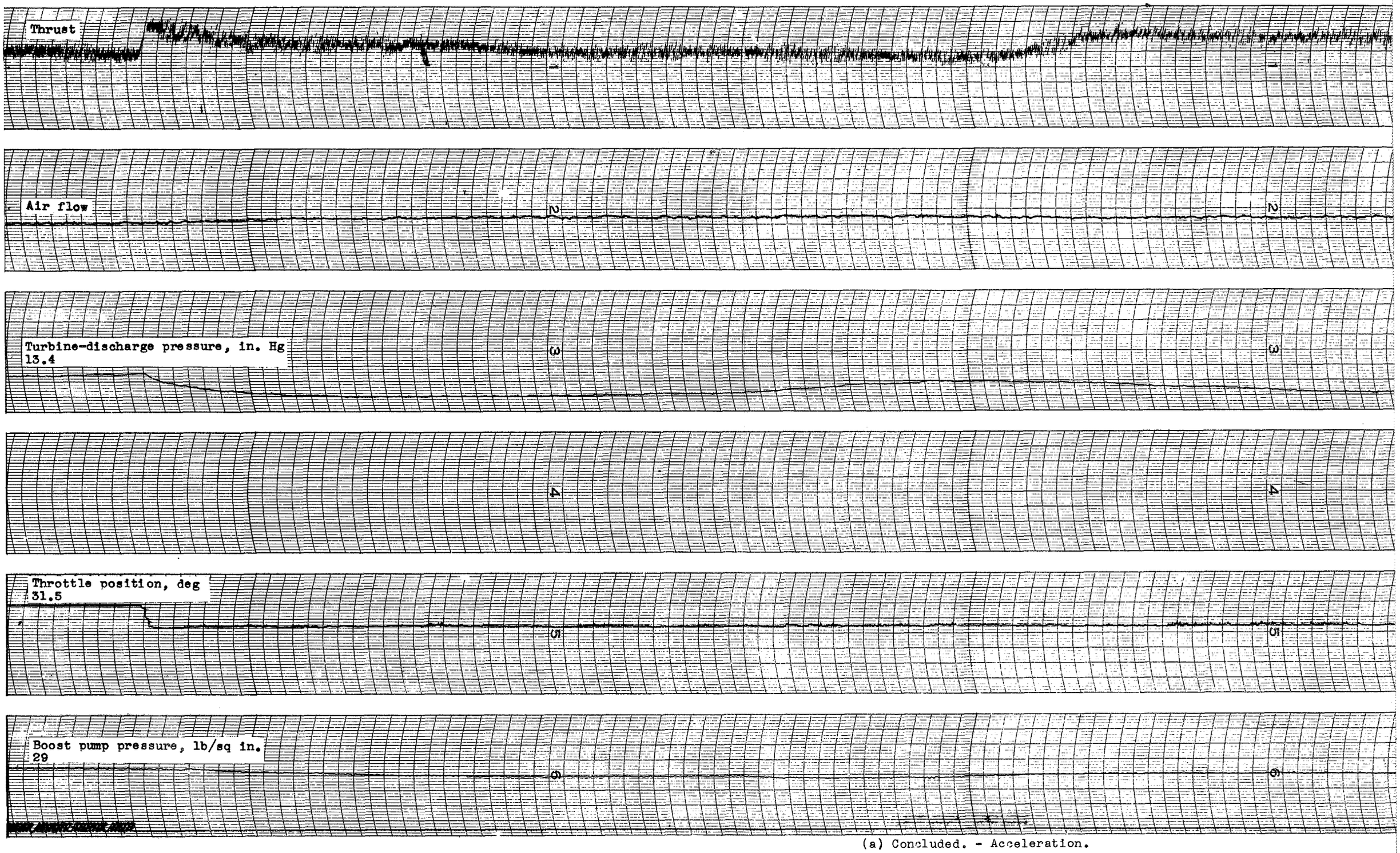






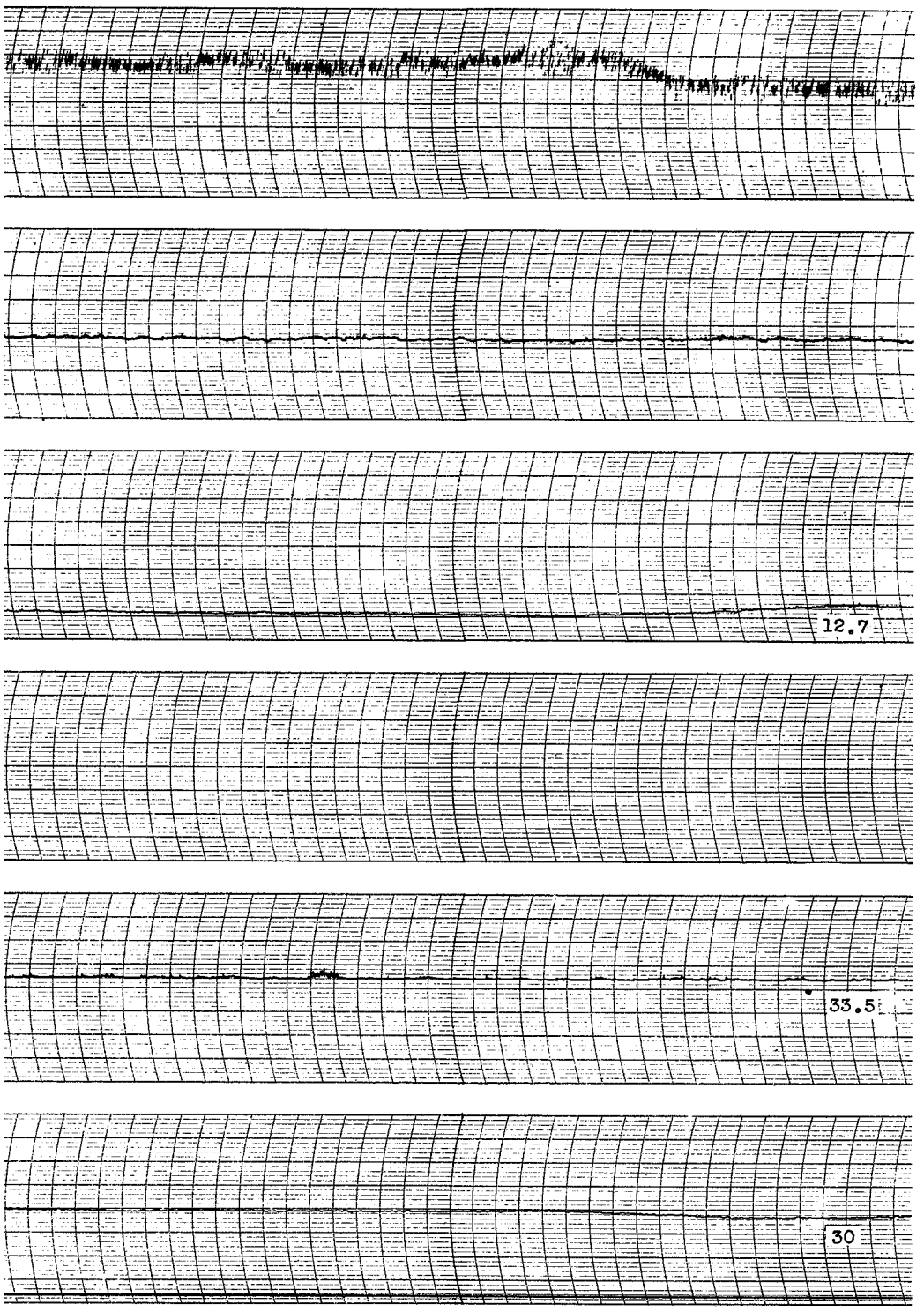


inal ram-pressure ratio, 1.2.

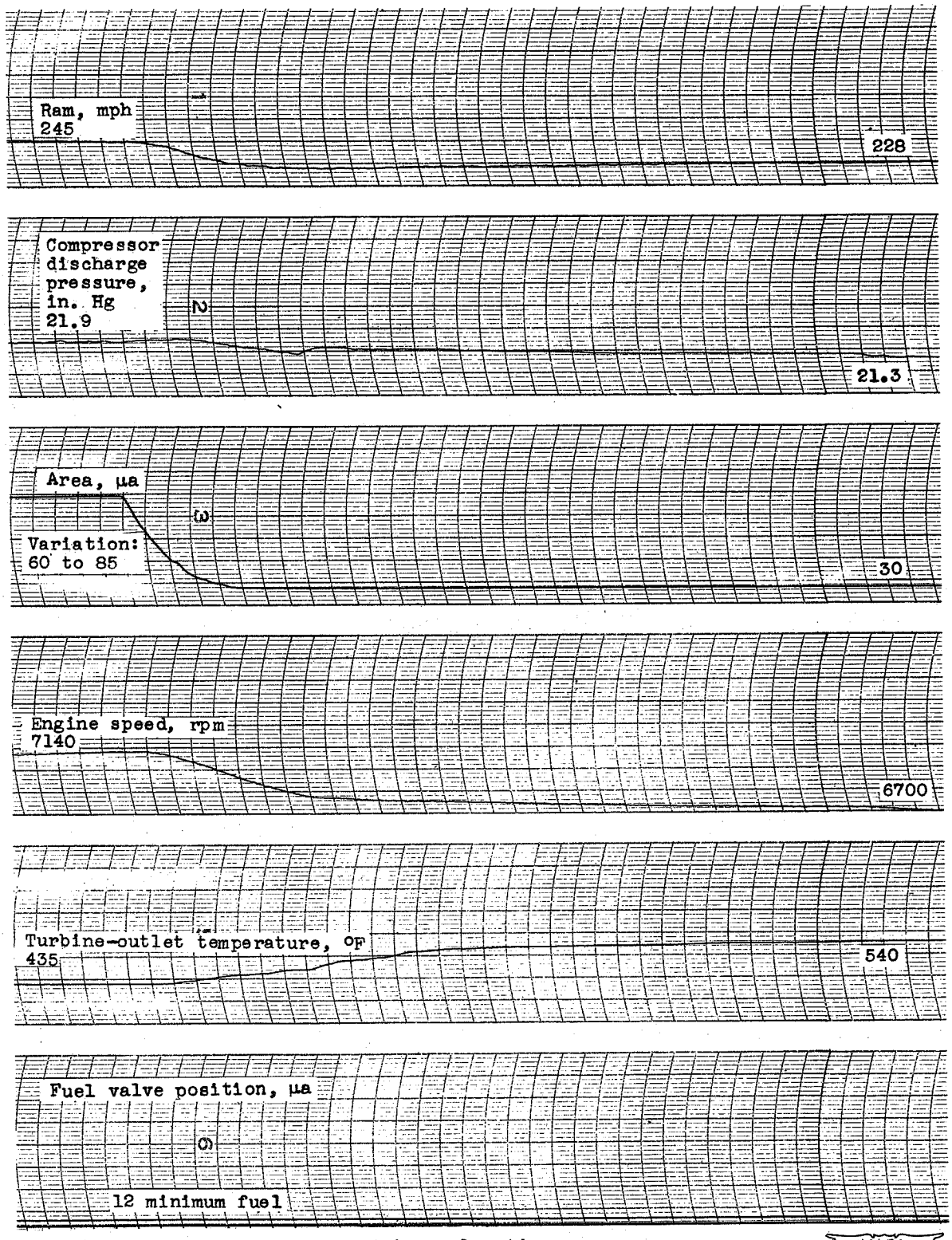


(a) Concluded. - Acceleration.

Figure 26. - Continued. - Transient operation of automatically-controlled engine. Throttle position, 31.5° to 33.5°; altitude, 25,000 fe

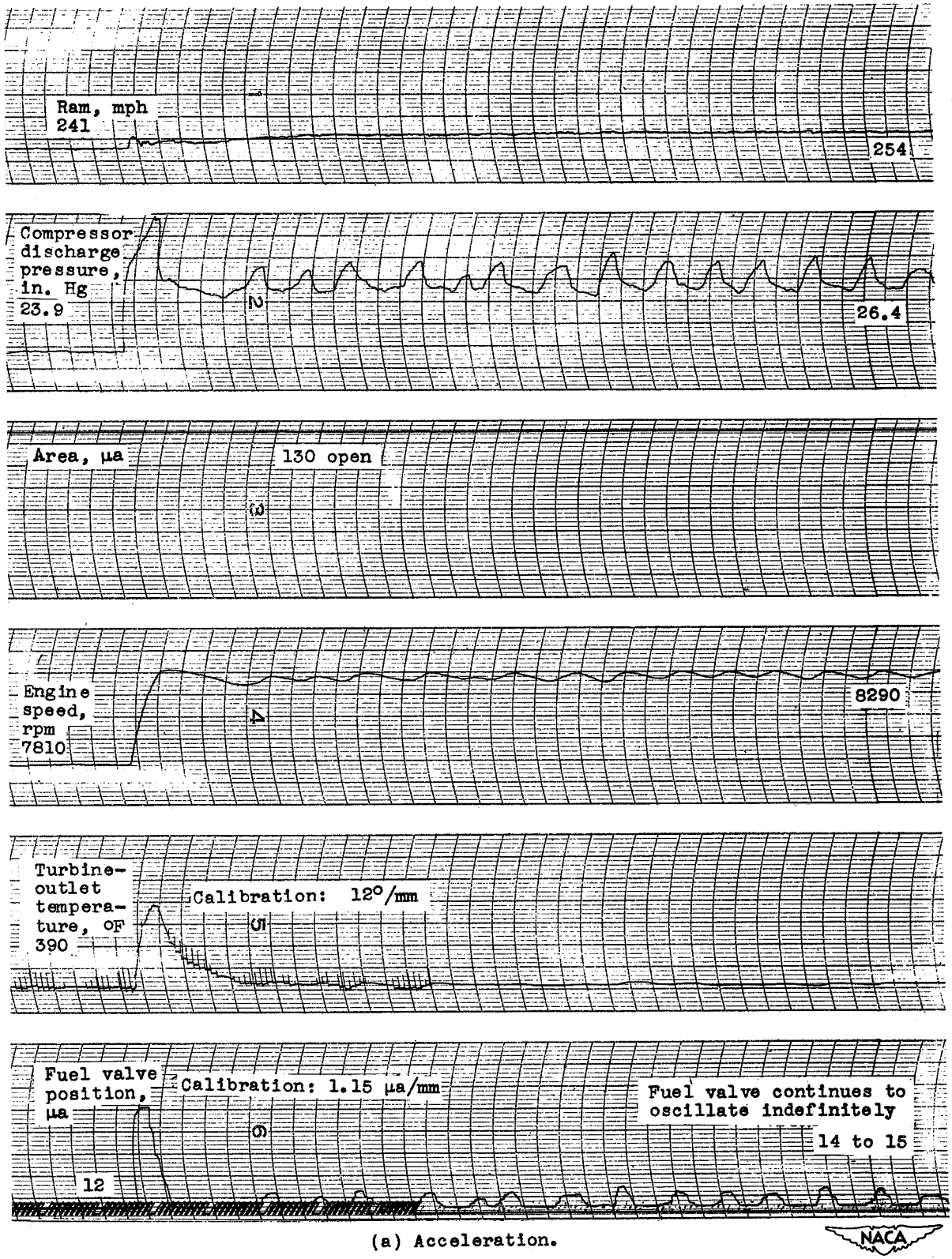


t; nominal ram-pressure ratio, 1.2.



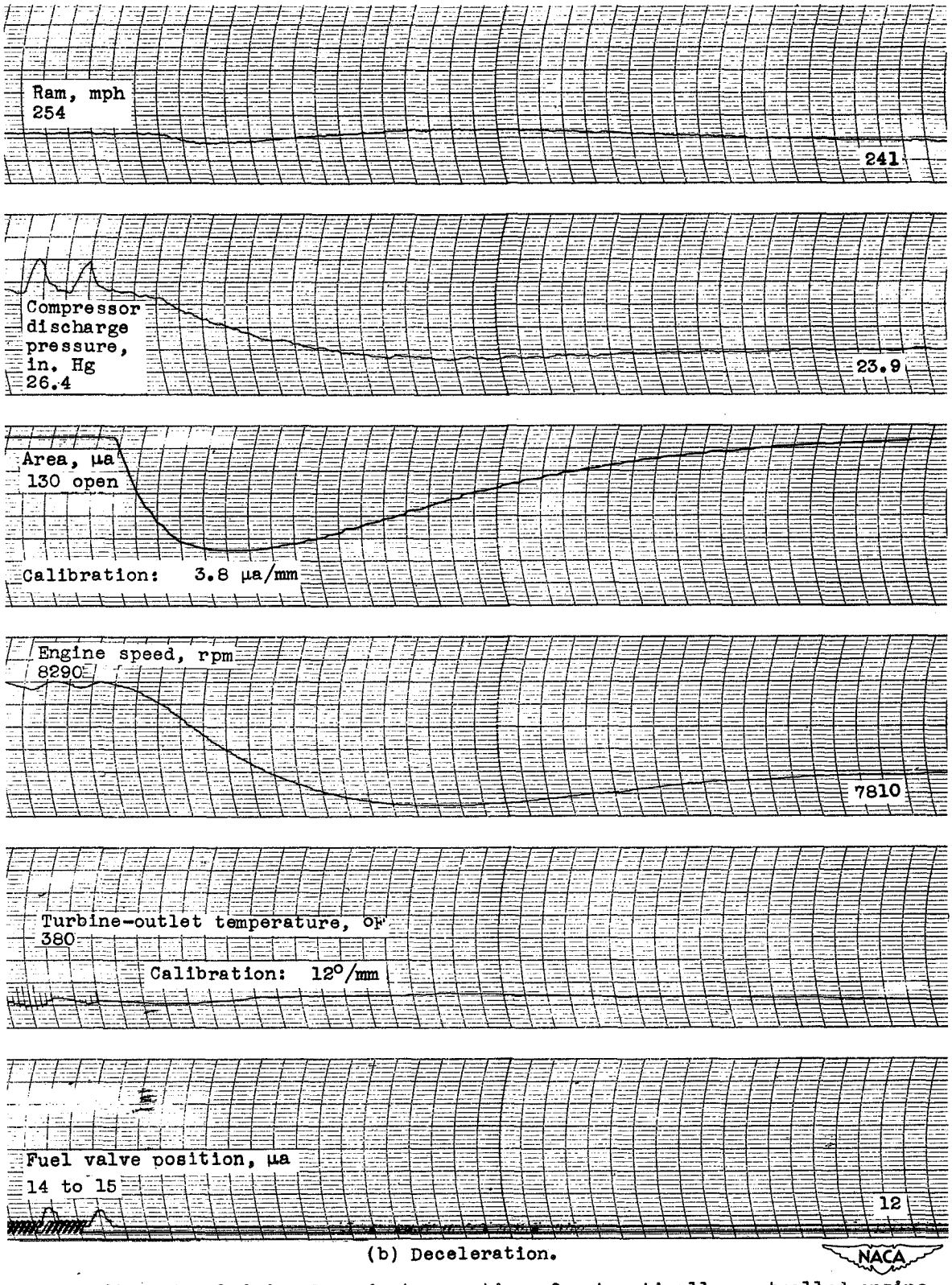
(b) Deceleration.

Figure 26. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 31.5° to 33.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(a) Acceleration.

Figure 27. - Transient operation of automatically-controlled engine. Throttle position, 34° to 37°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 27. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 34° to 37°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.

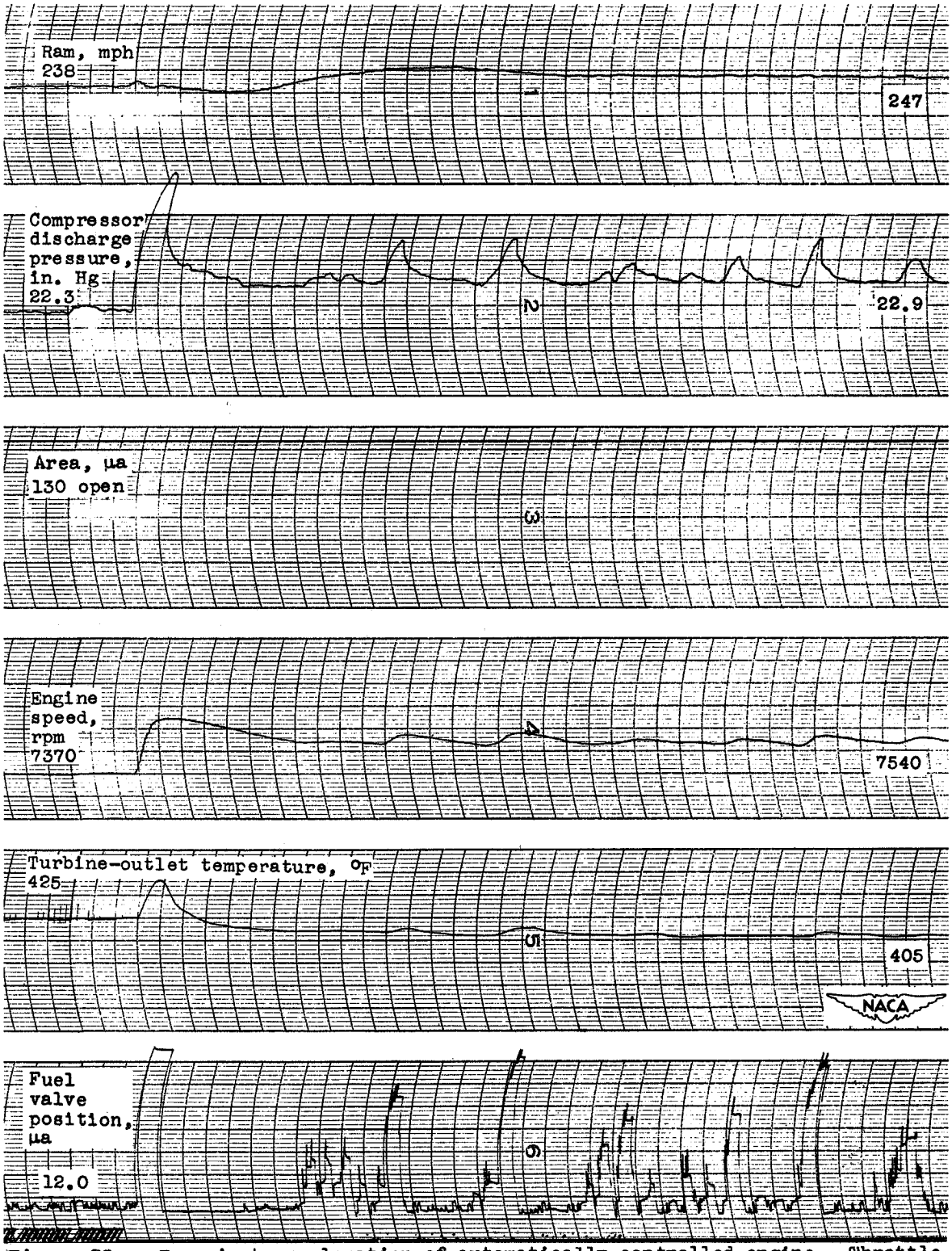
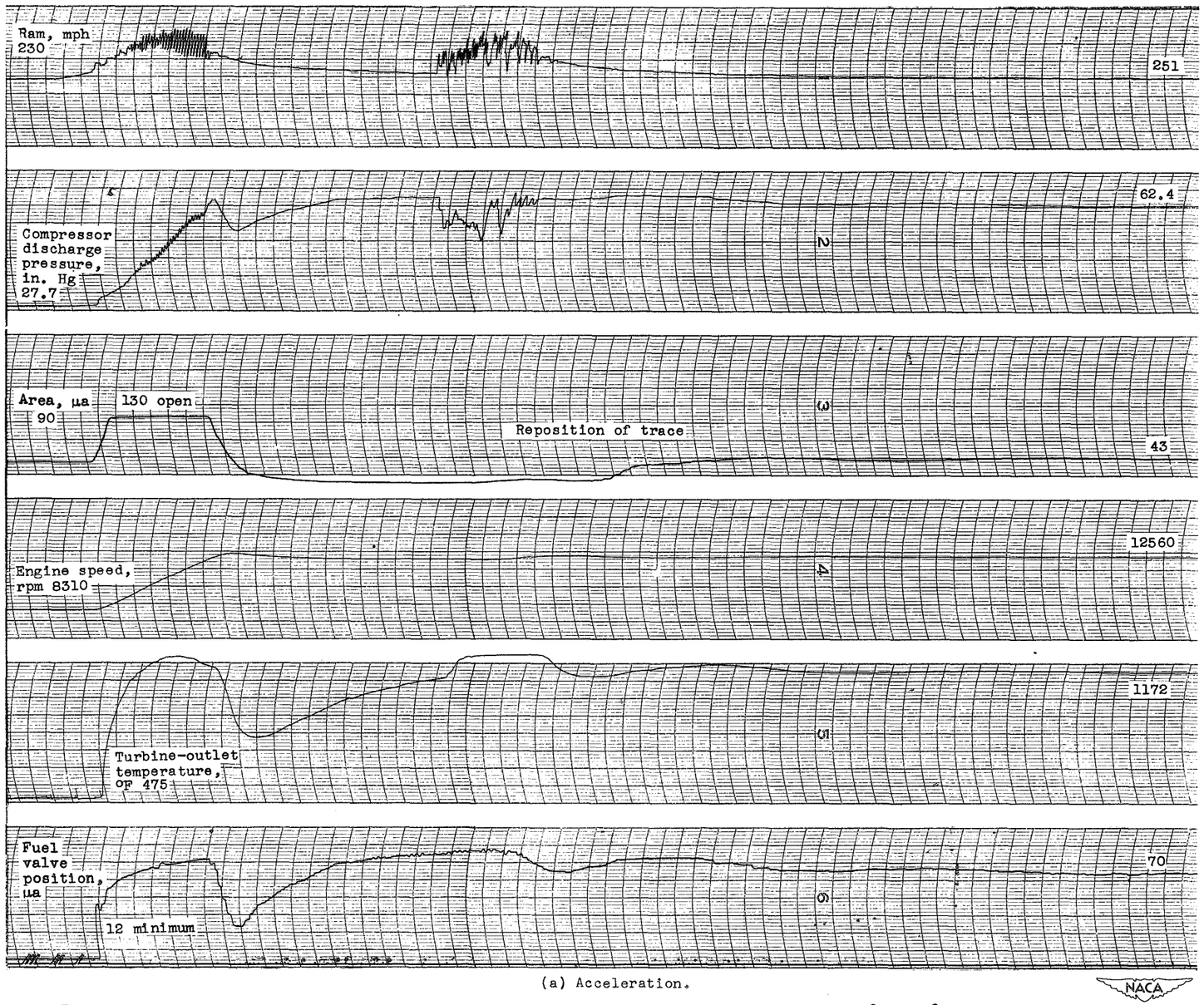
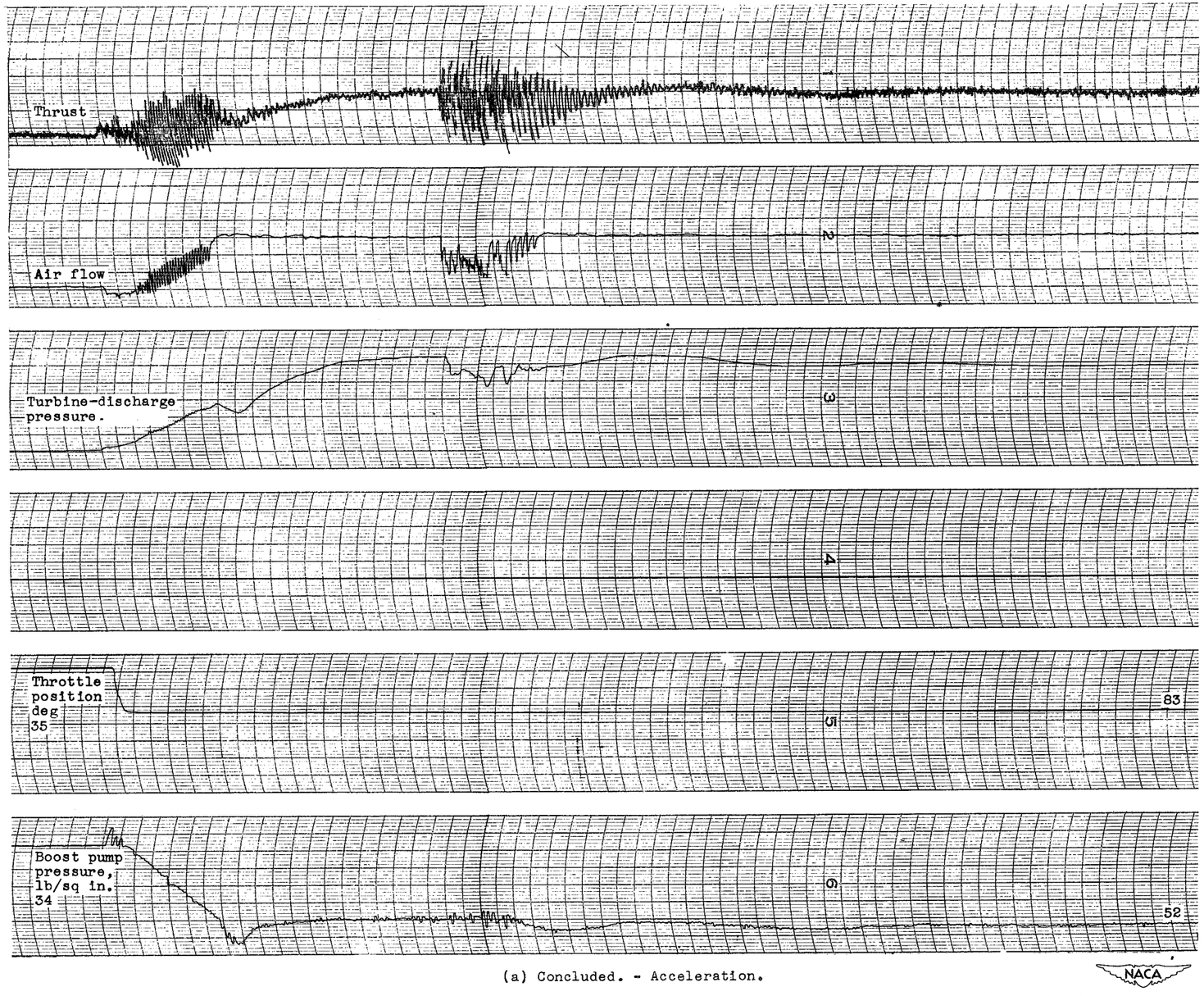


Figure 28. - Transient acceleration of automatically-controlled engine. Throttle position, 35° to 35.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



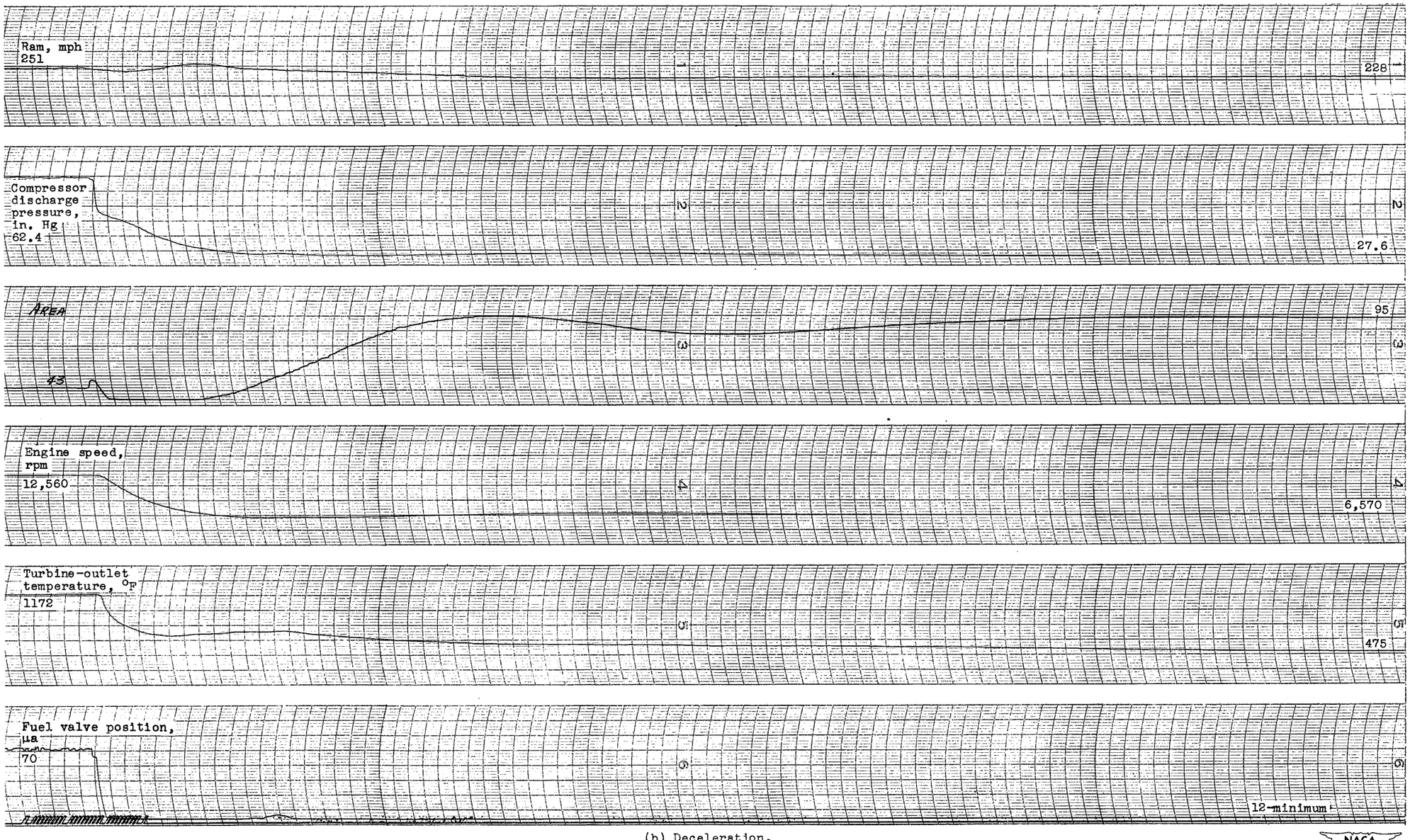
(a) Acceleration.

Figure 29. - Transient operation of automatically-controlled engine. Throttle position, 35° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



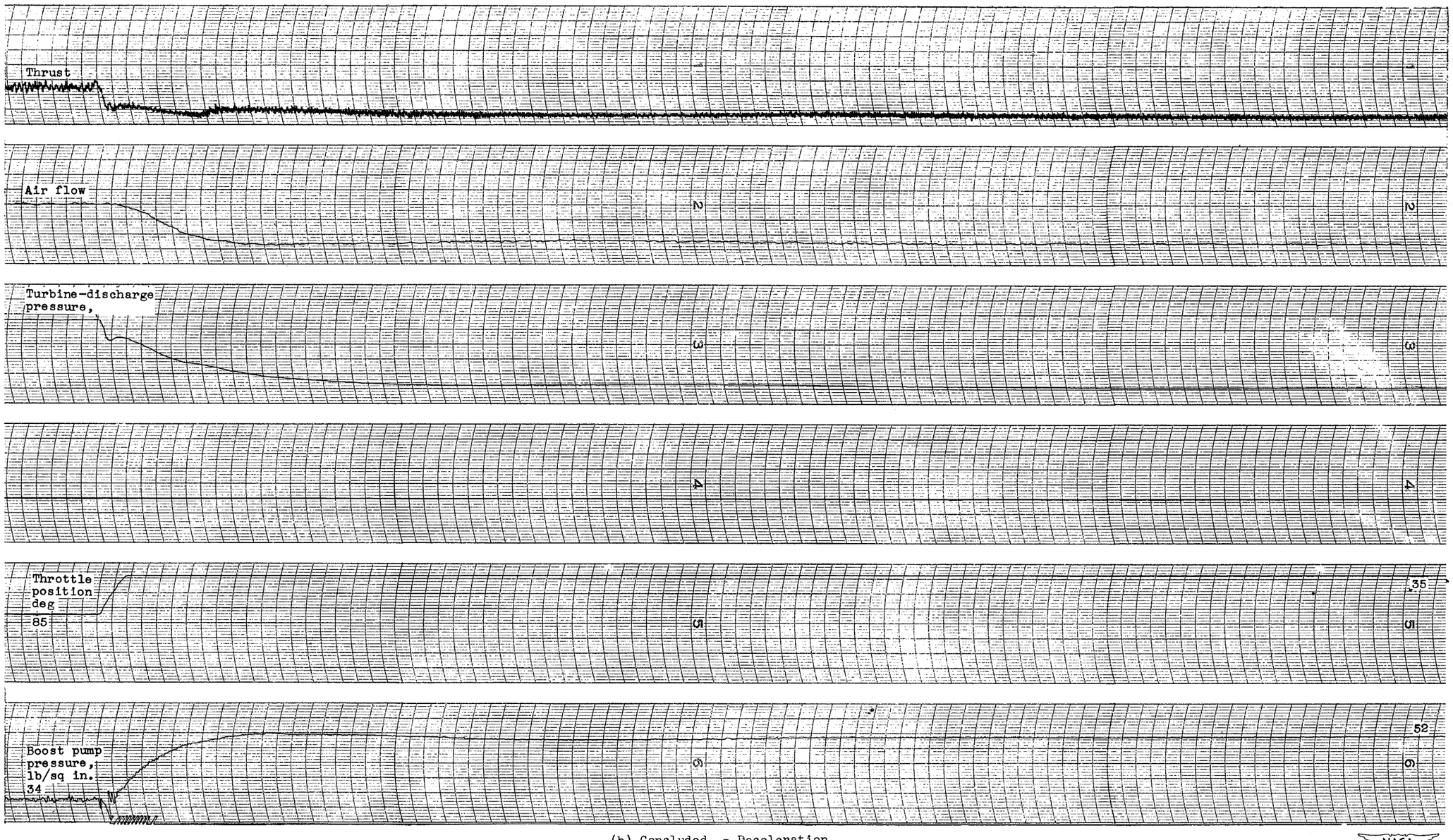
(a) Concluded. - Acceleration.

Figure 29. - Continued. Transient operation of automatically-controlled engine. Throttle position, 35° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



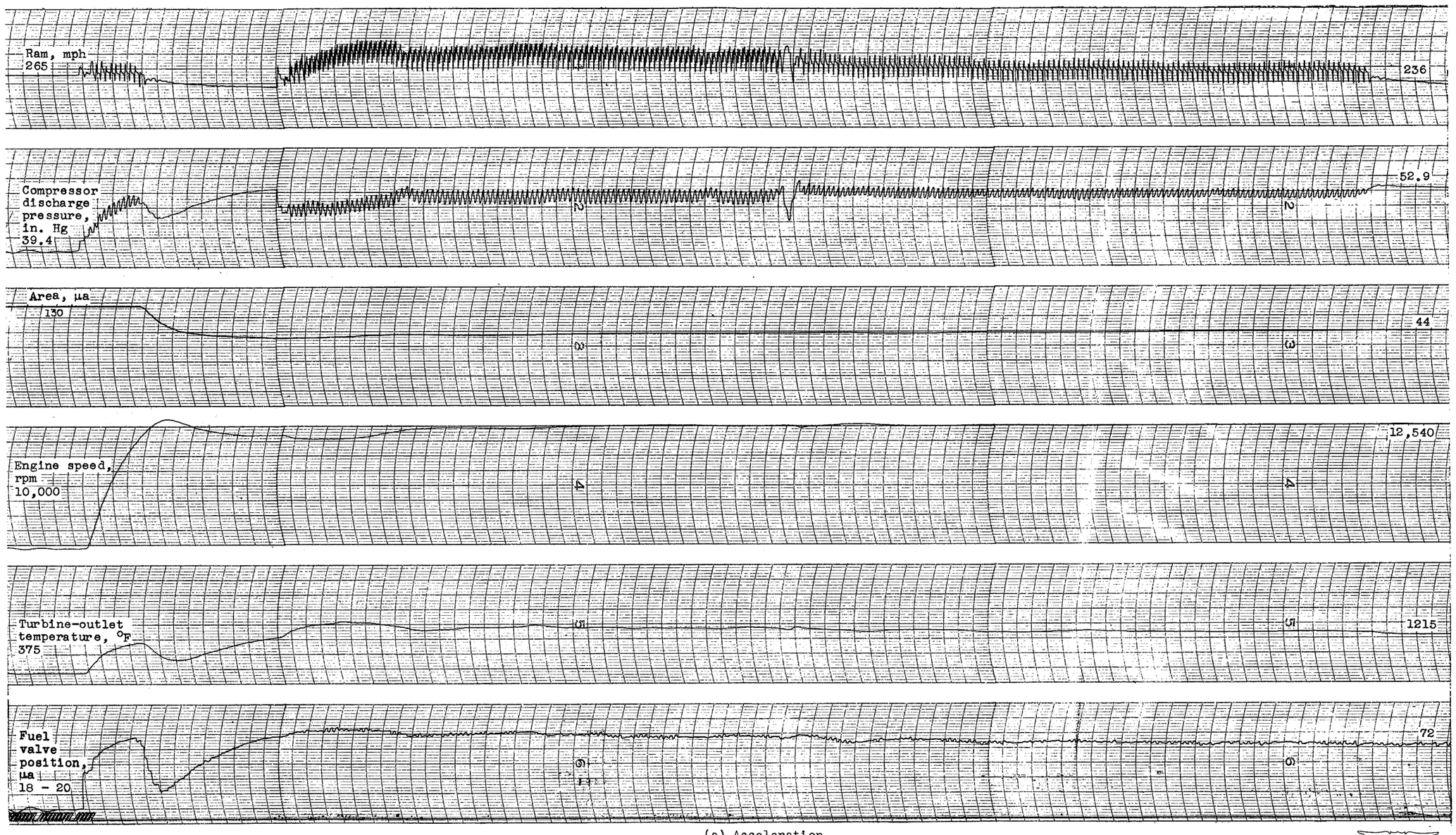
(b) Deceleration.

Figure 29. - Continued. Transient operation of automatically-controlled engine. Throttle position, 35° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio 1.2.



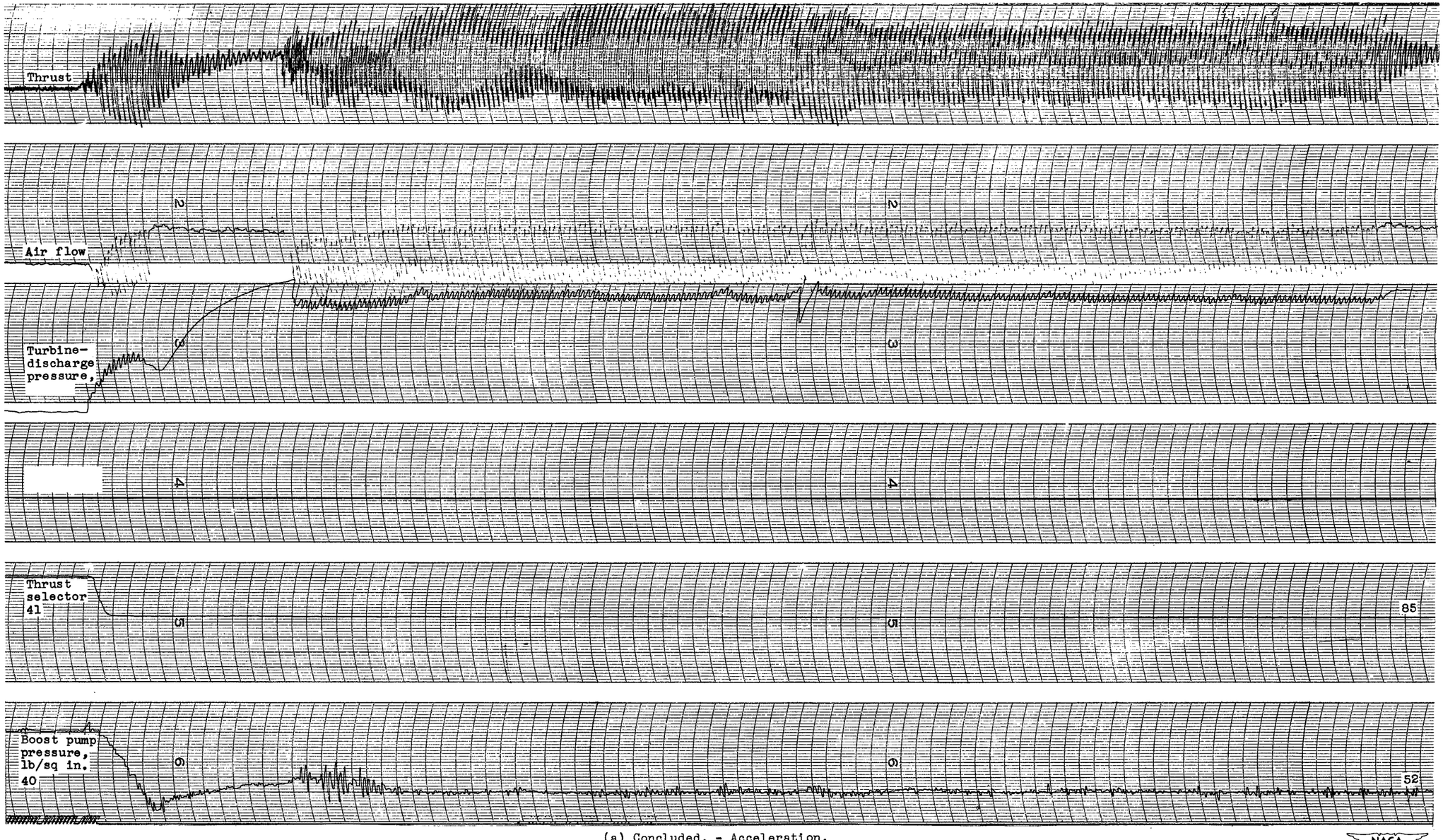
(b) Concluded. - Deceleration.

Figure 29. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 35° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio 1.2.



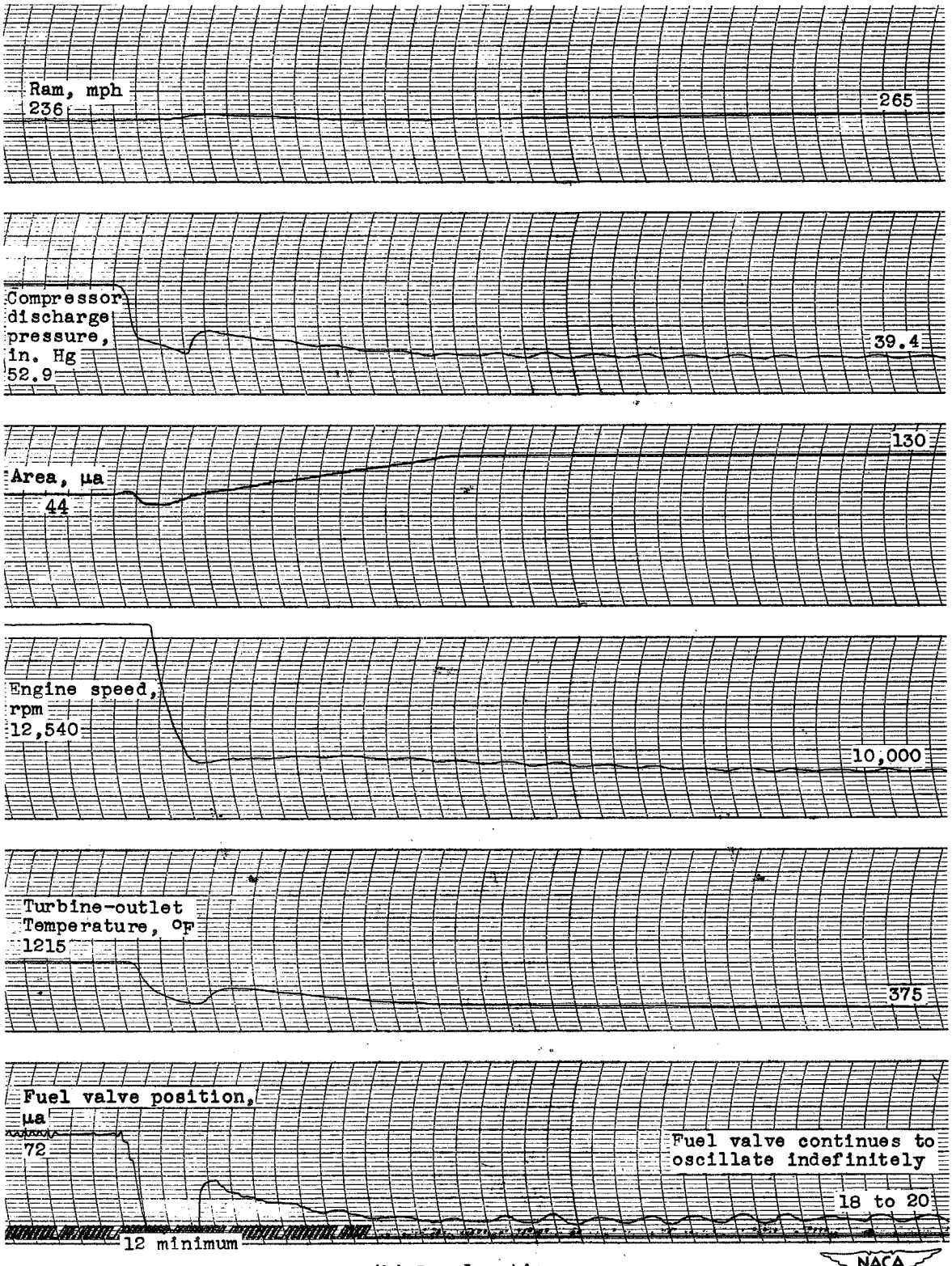
(a) Acceleration.

Figure 30. - Transient operation of automatically-controlled engine. Throttle position, 41° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



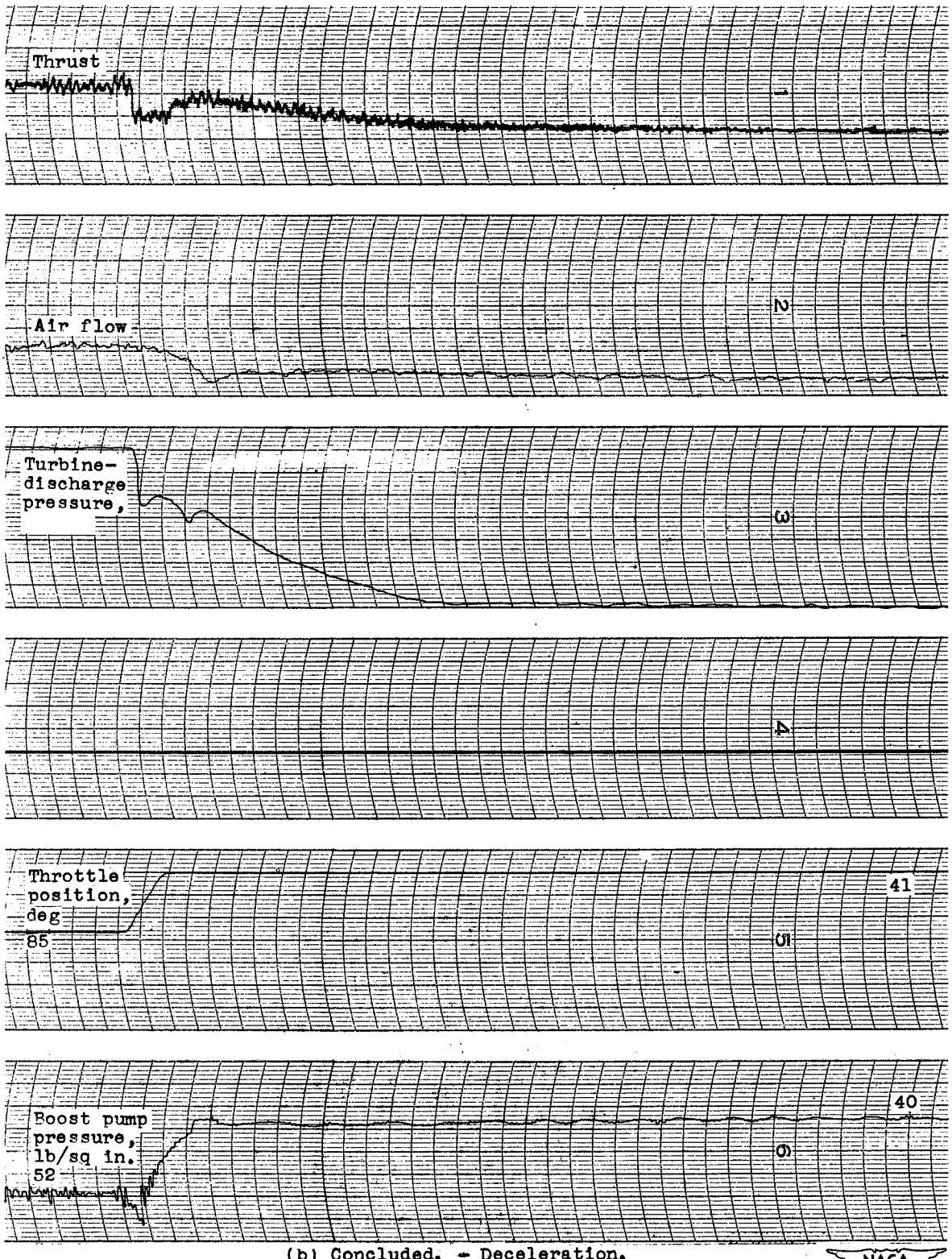
(a) Concluded. - Acceleration.

Figure 30. - Continued. Transient operation of automatically-controlled engine. Throttle position, 41° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 30. - Continued. Transient operation of automatically-controlled engine. Throttle position, 41° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 30. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 41° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.

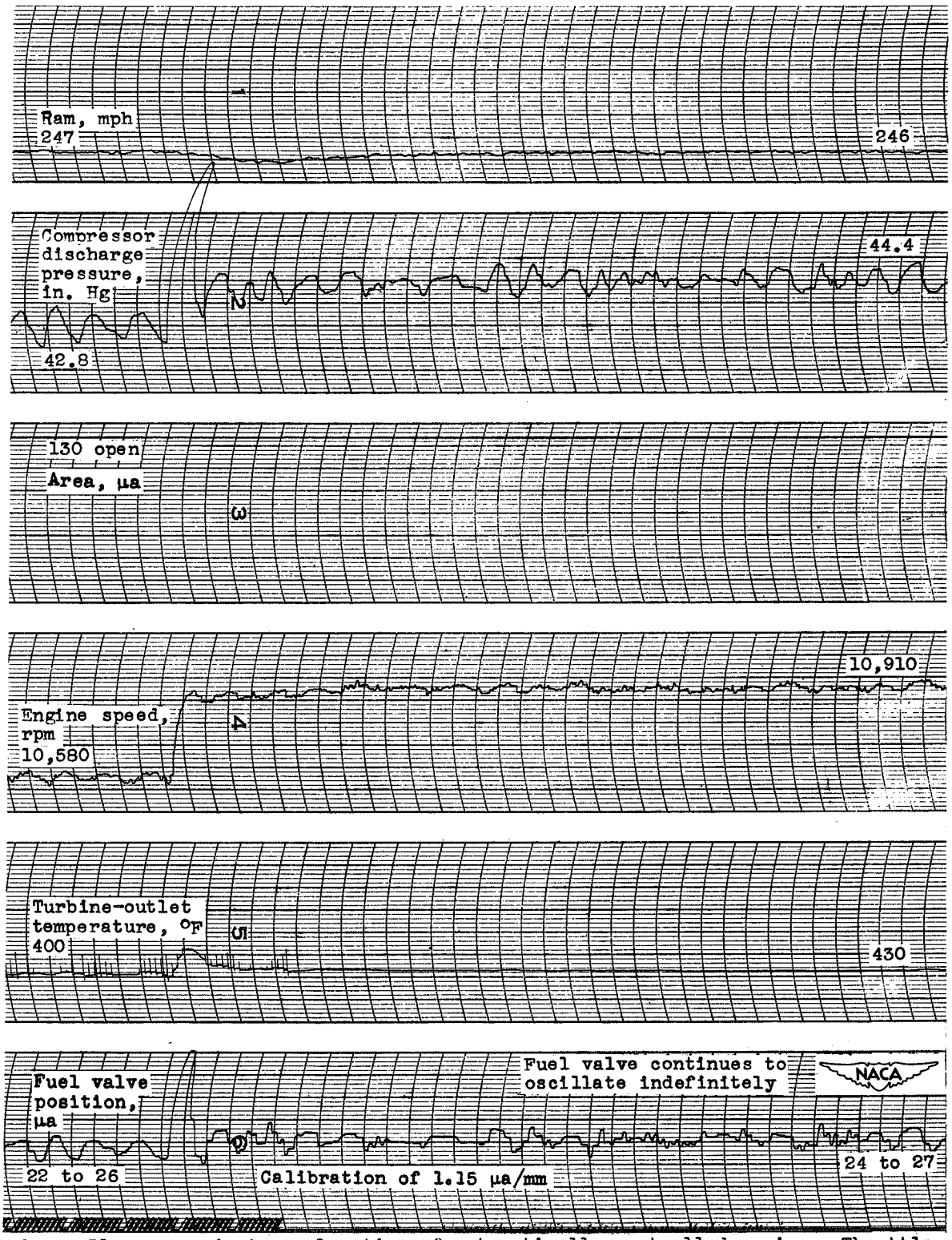
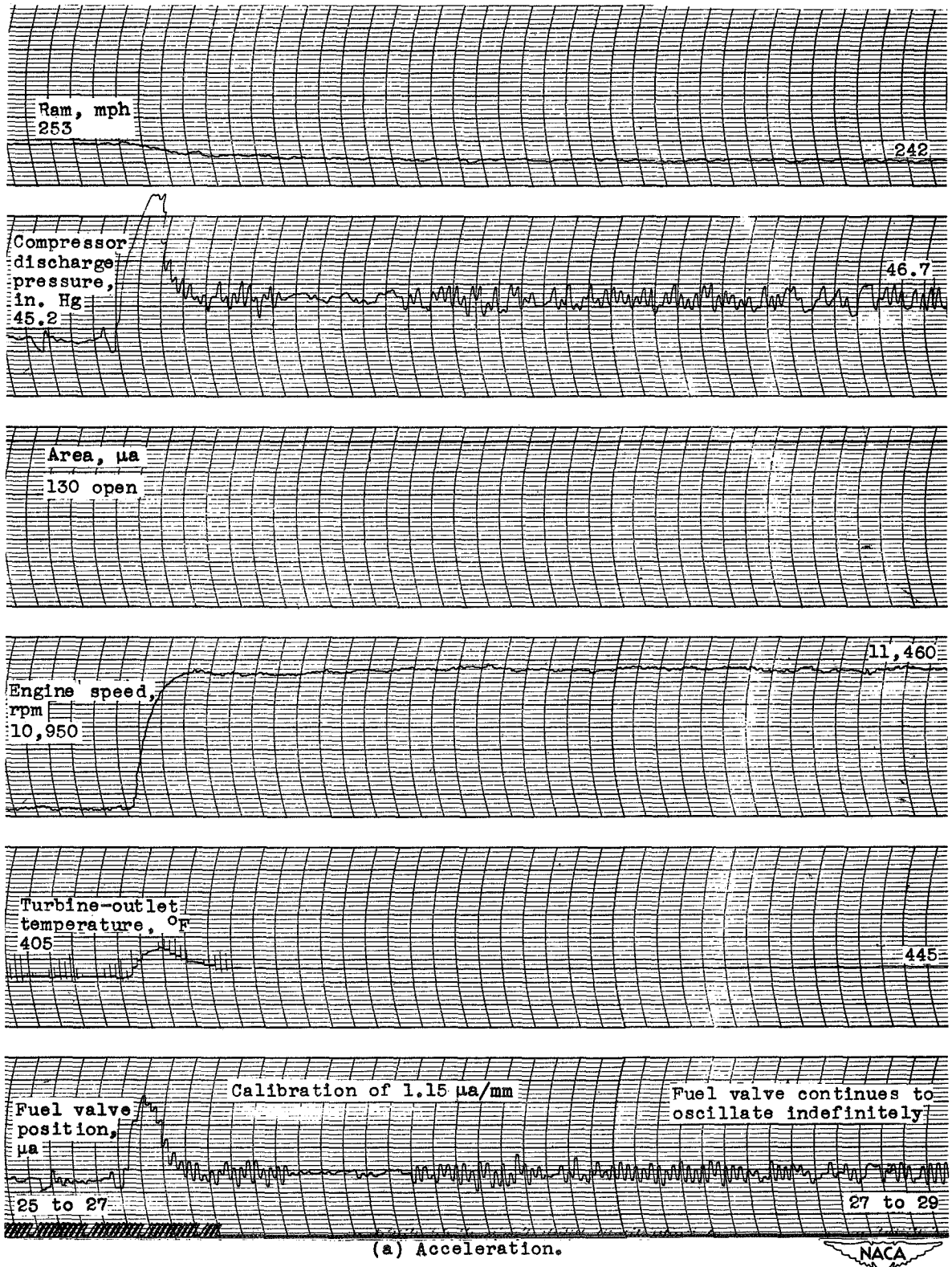
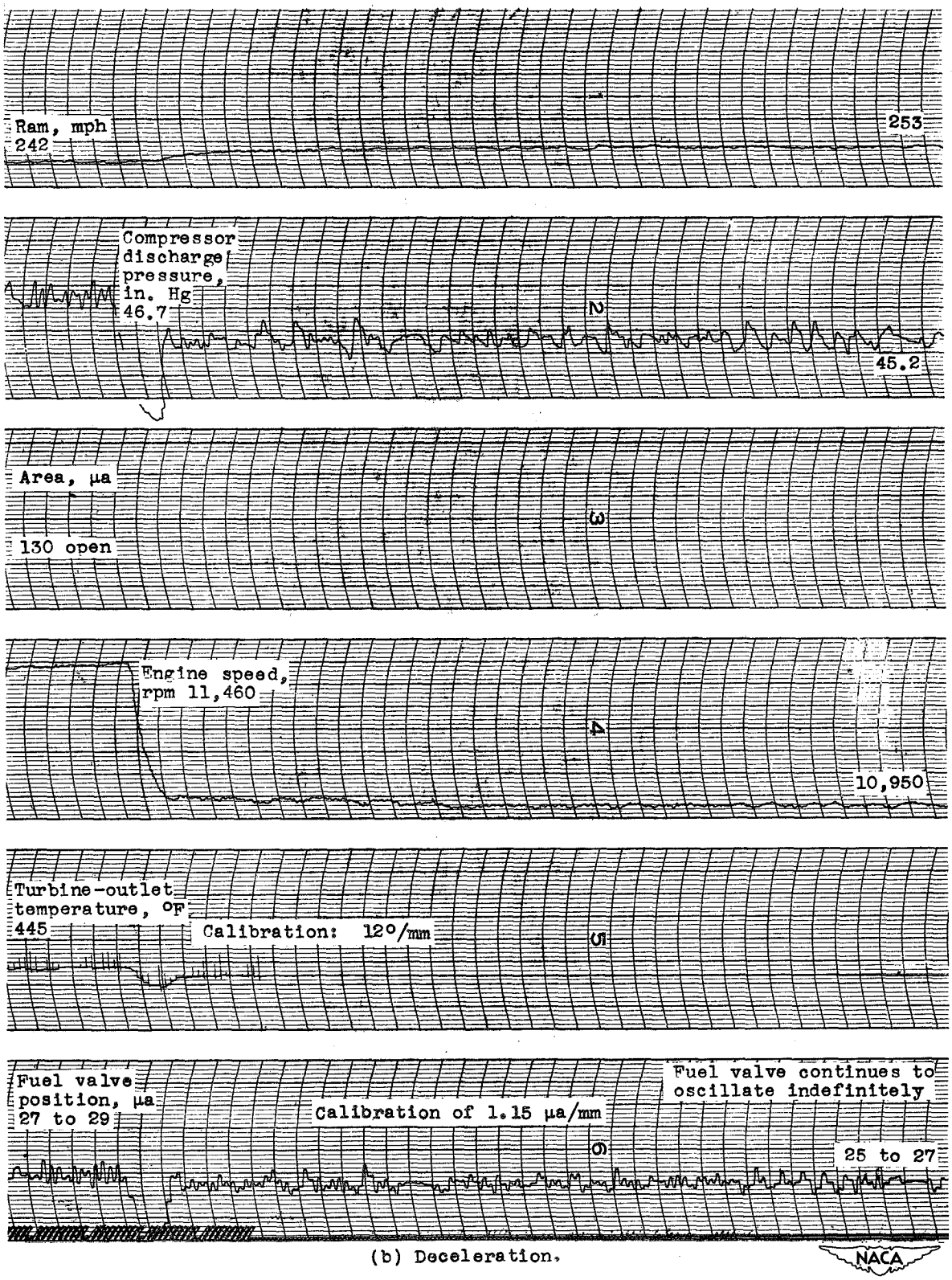


Figure 31. - Transient acceleration of automatically-controlled engine. Throttle position, 43.5 to 44 ; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(a) Acceleration.

Figure 32. - Transient operation of automatically-controlled engine. Throttle position, 43.5° to 55°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 32. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 43.5° to 55°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.

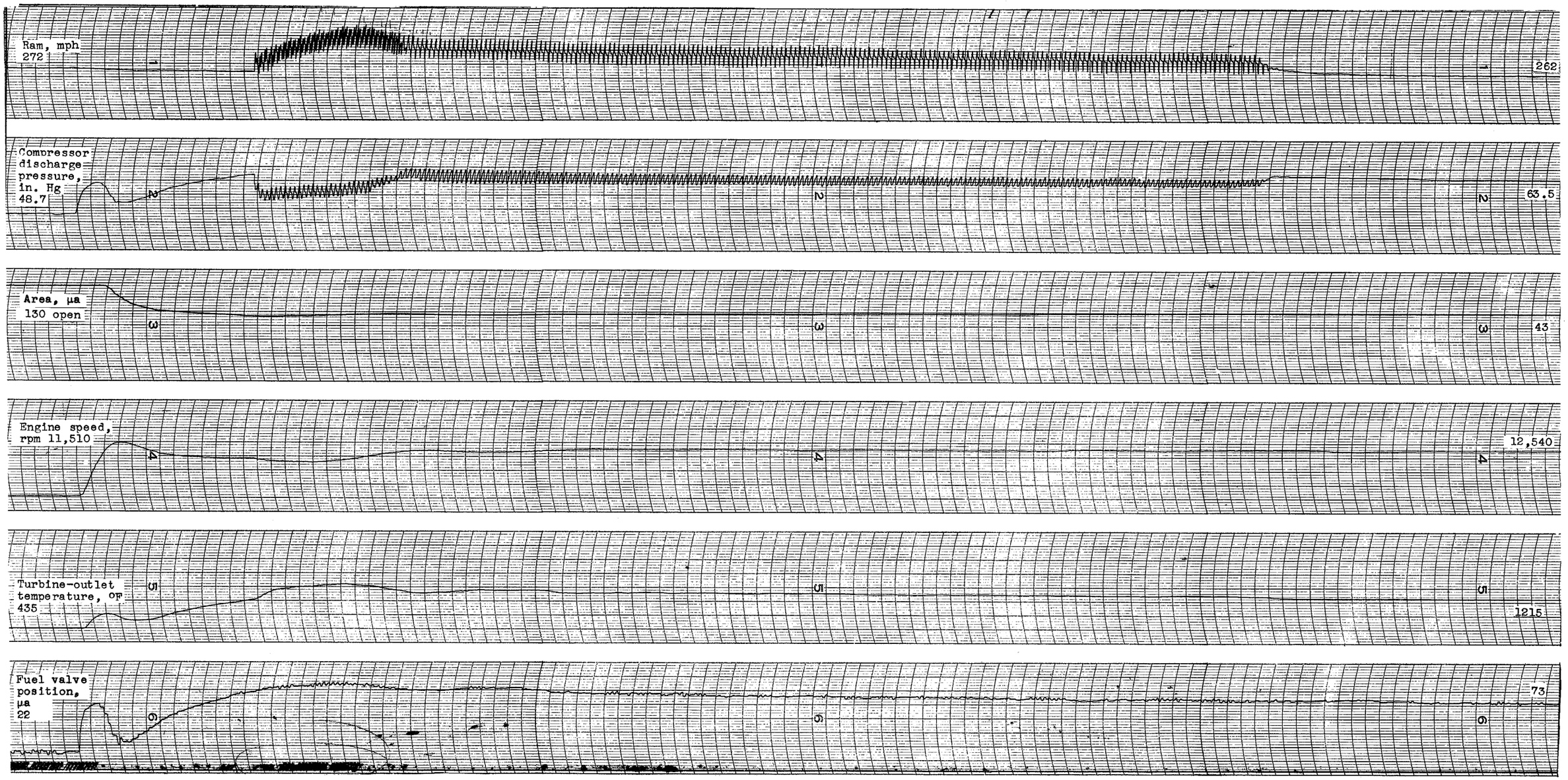


Figure 33. - Transient acceleration of automatically-controlled engine. Throttle position, 55° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.

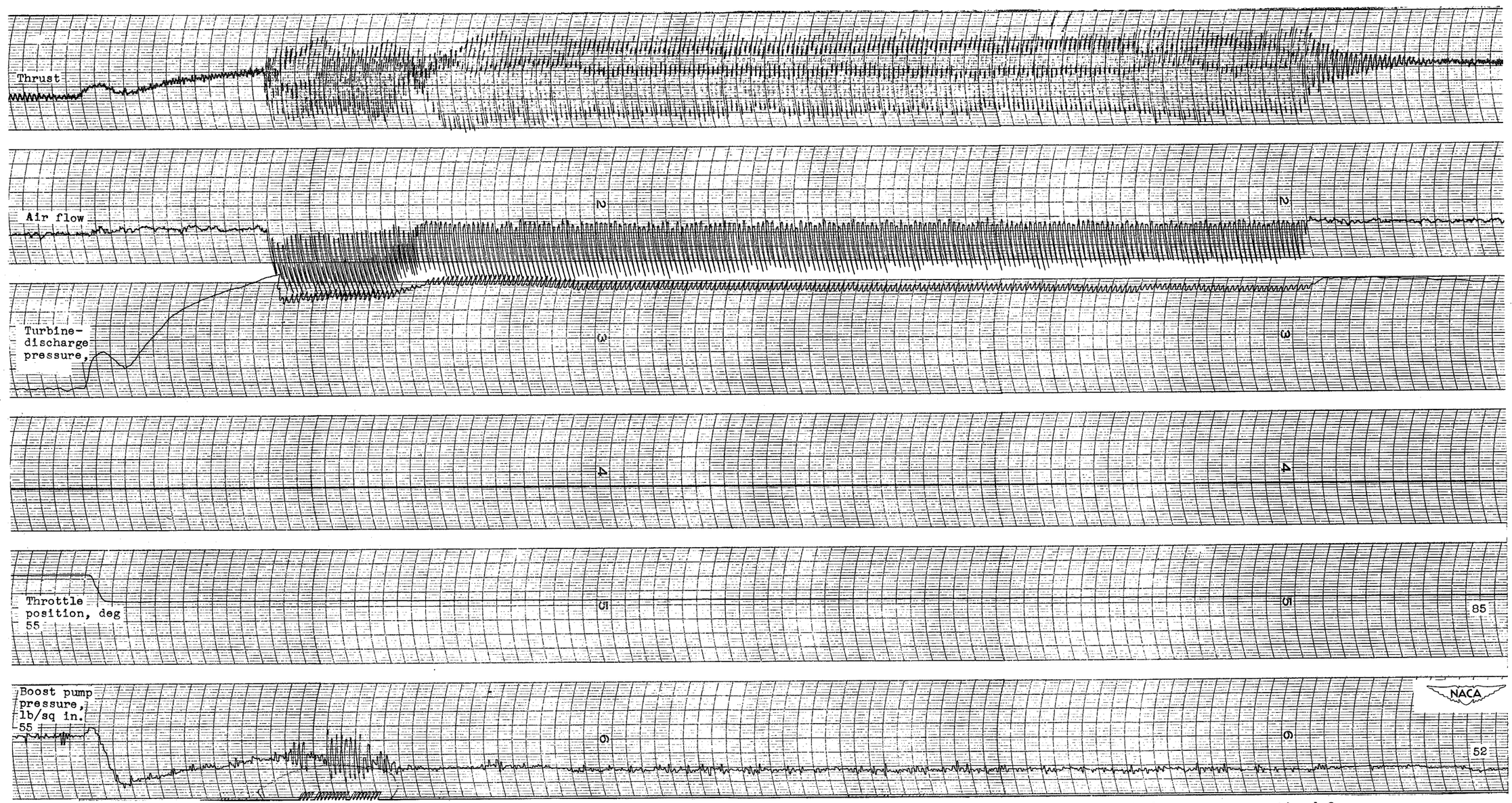


Figure 33. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 55° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.

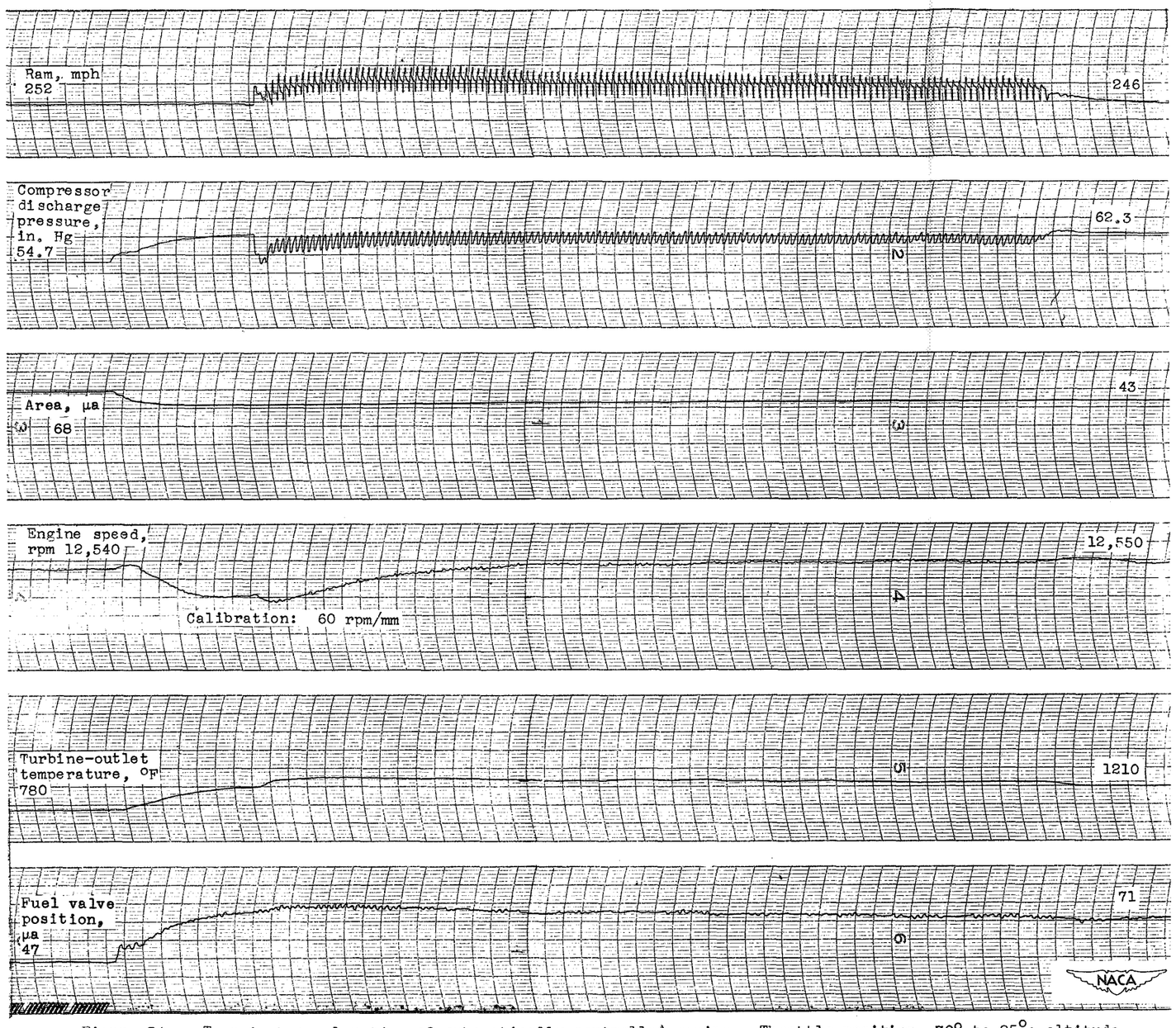


Figure 34. - Transient acceleration of automatically-controlled engine. Throttle position, 70° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.

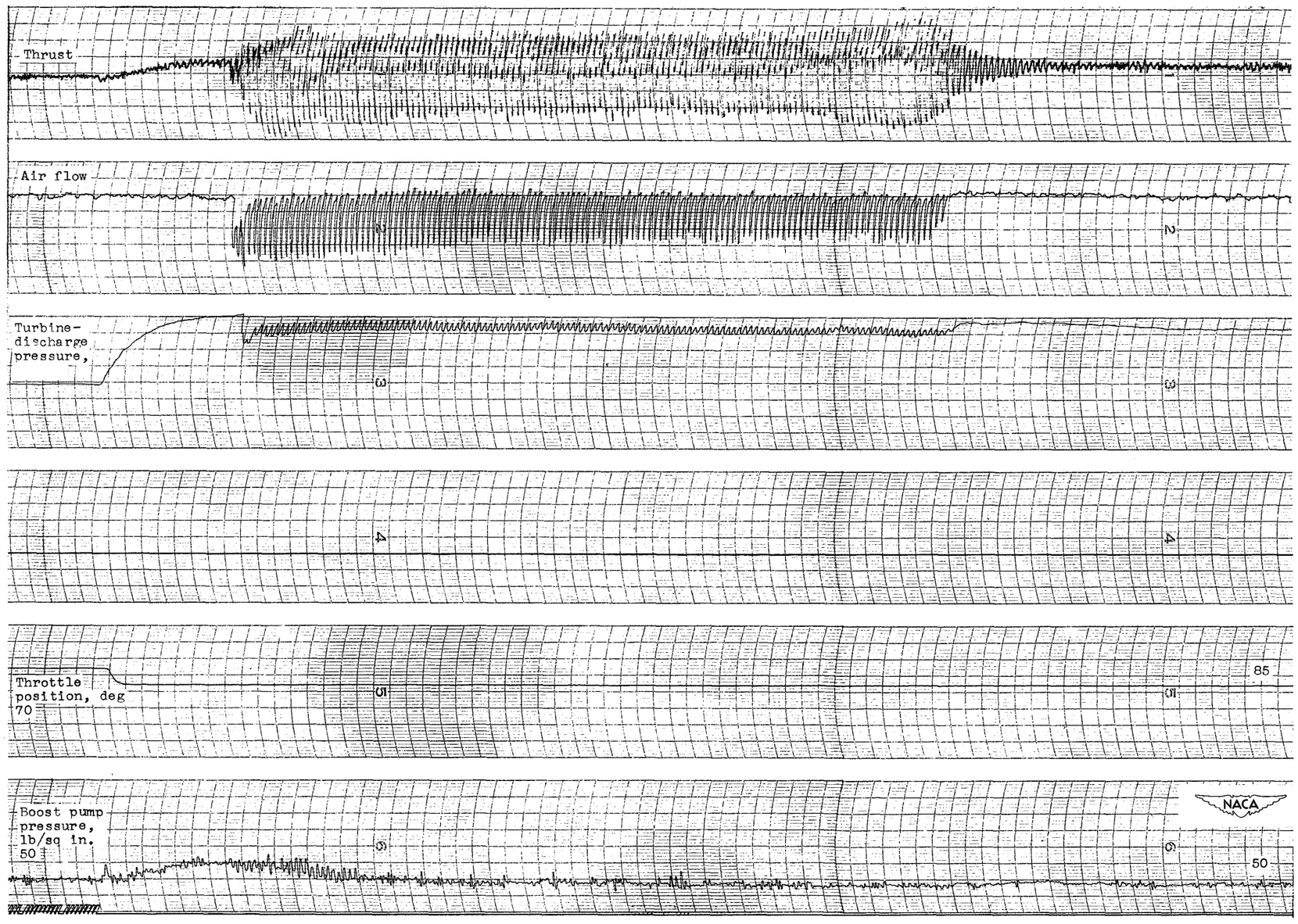
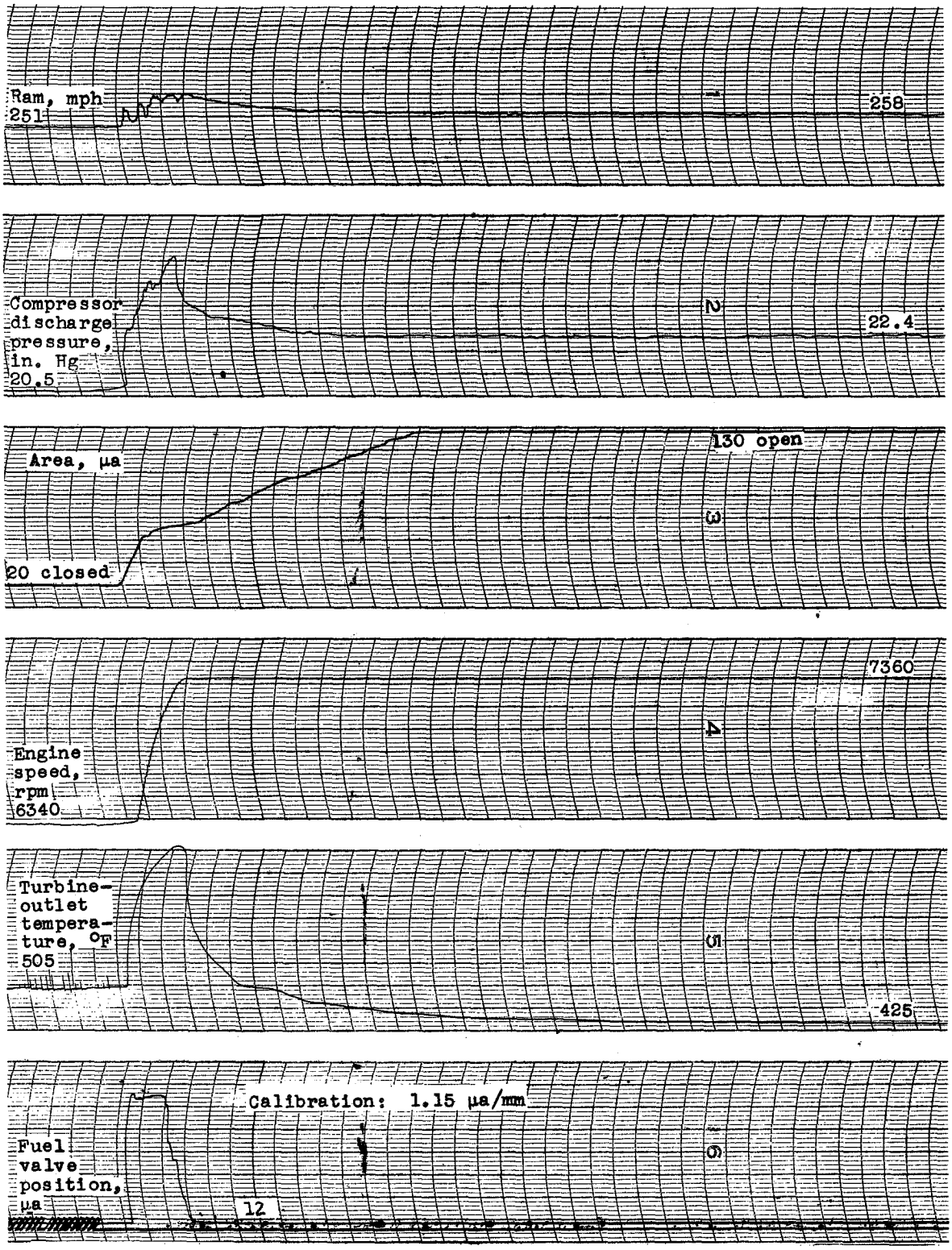
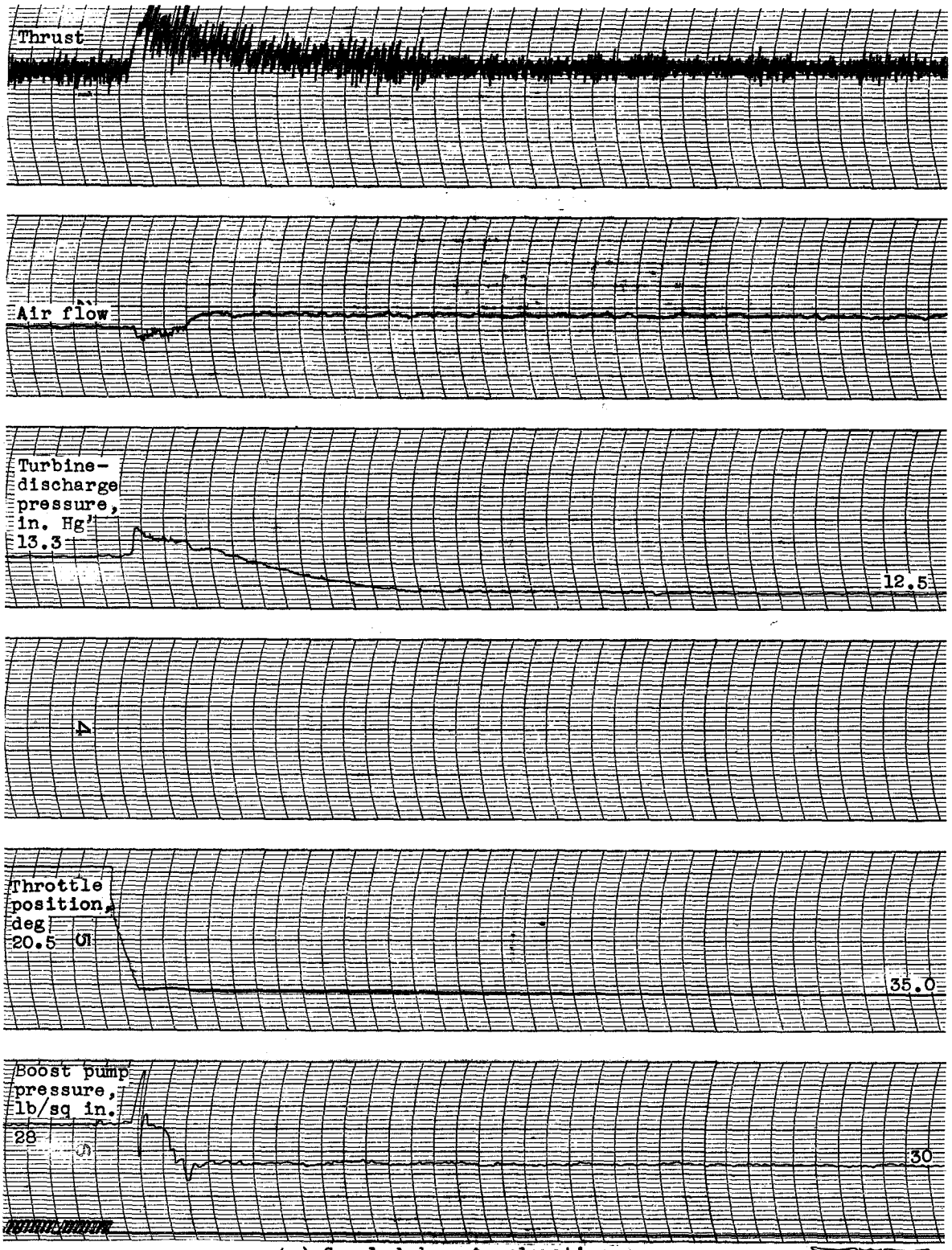


Figure 34. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 70° to 85°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2 acceleration.



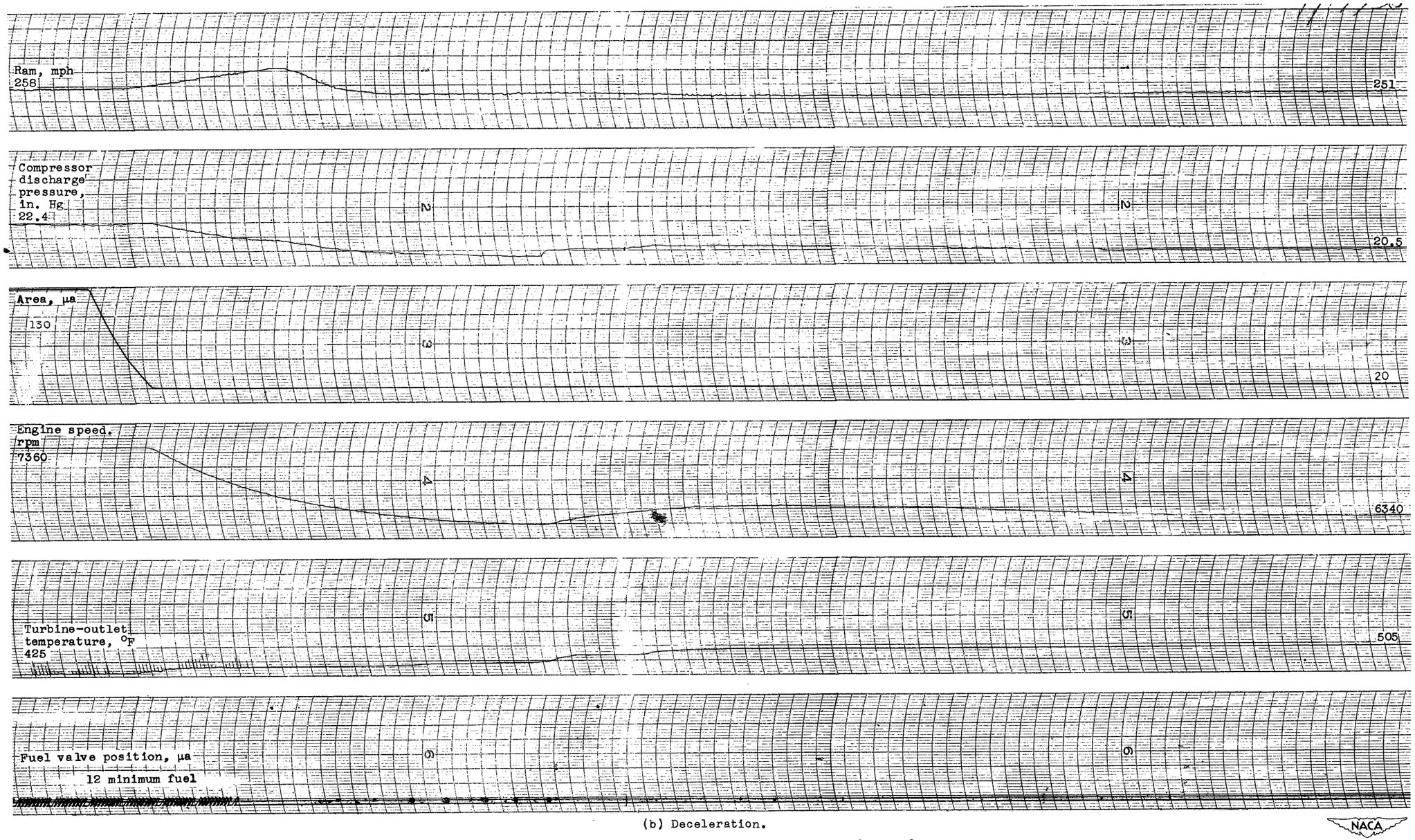
(a) Acceleration.

Figure 35. - Transient operation of automatically-controlled engine. Throttle position, 20.5° to 35°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



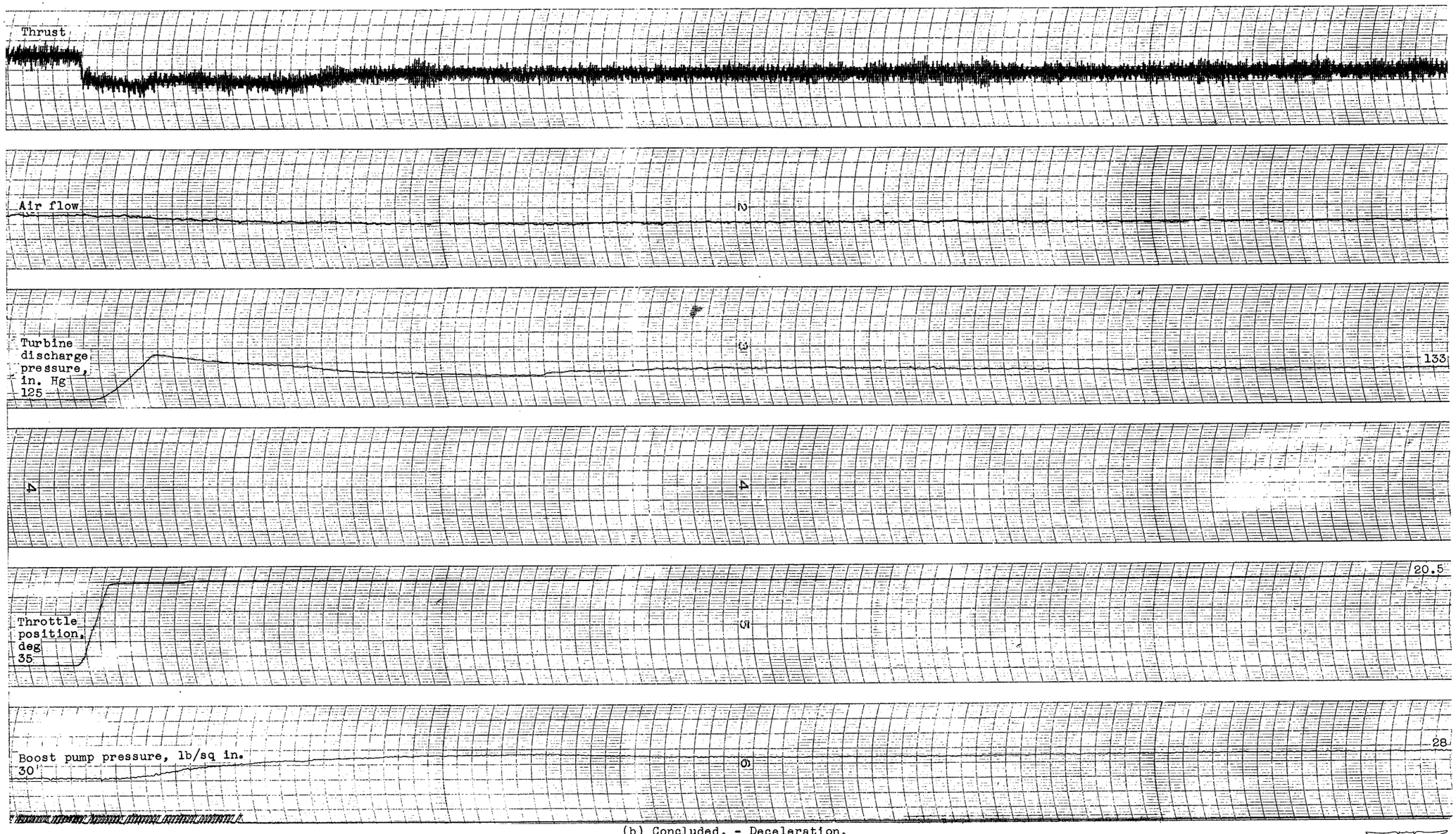
(a) Concluded. - Acceleration.

Figure 35. - Continued. Transient operation of automatically-controlled engine. Throttle position, 20.5° to 35°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



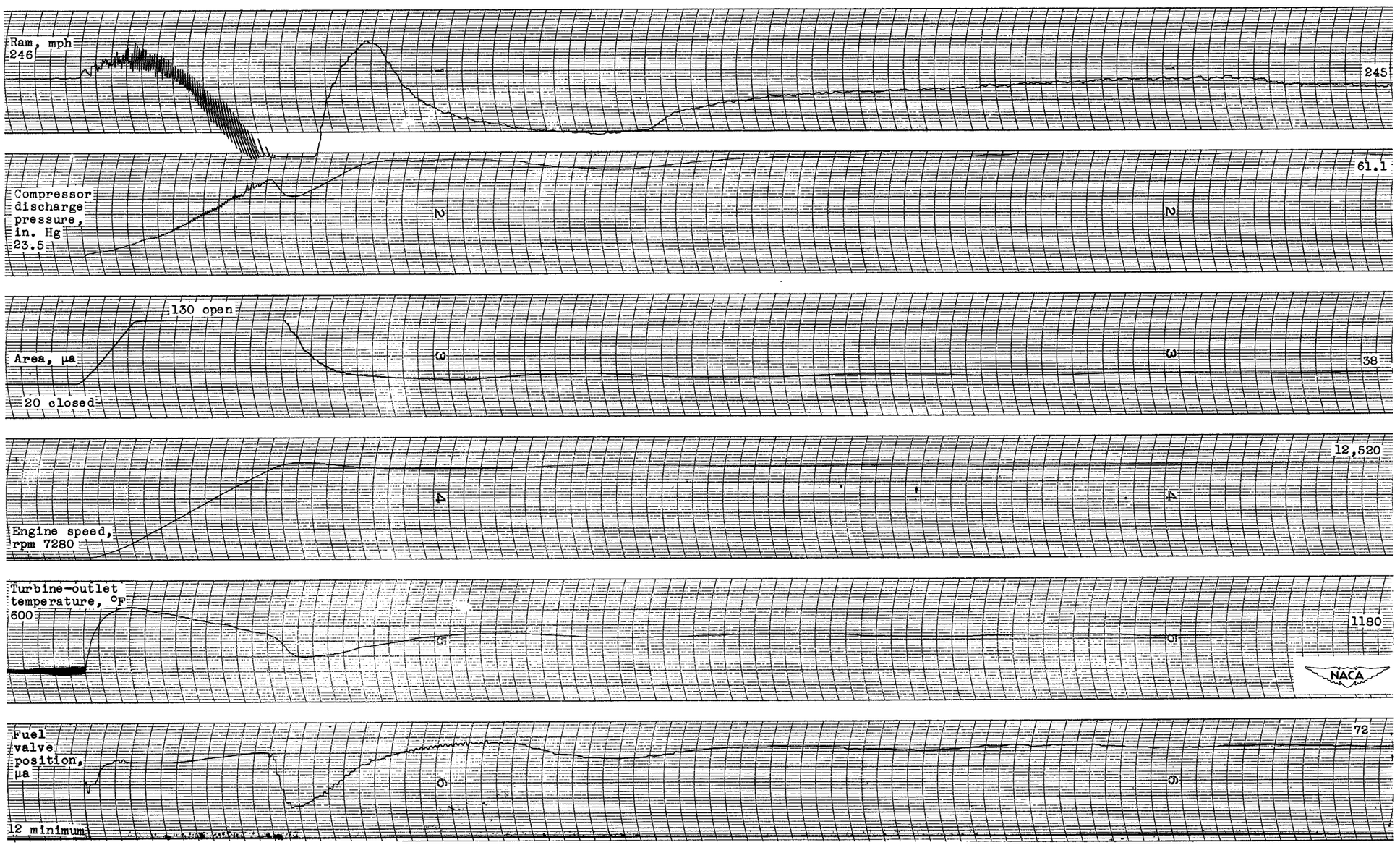
(b) Deceleration.

Figure 35. - Continued. Transient operation of automatically-controlled engine. Throttle position, 20.5° to 35°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



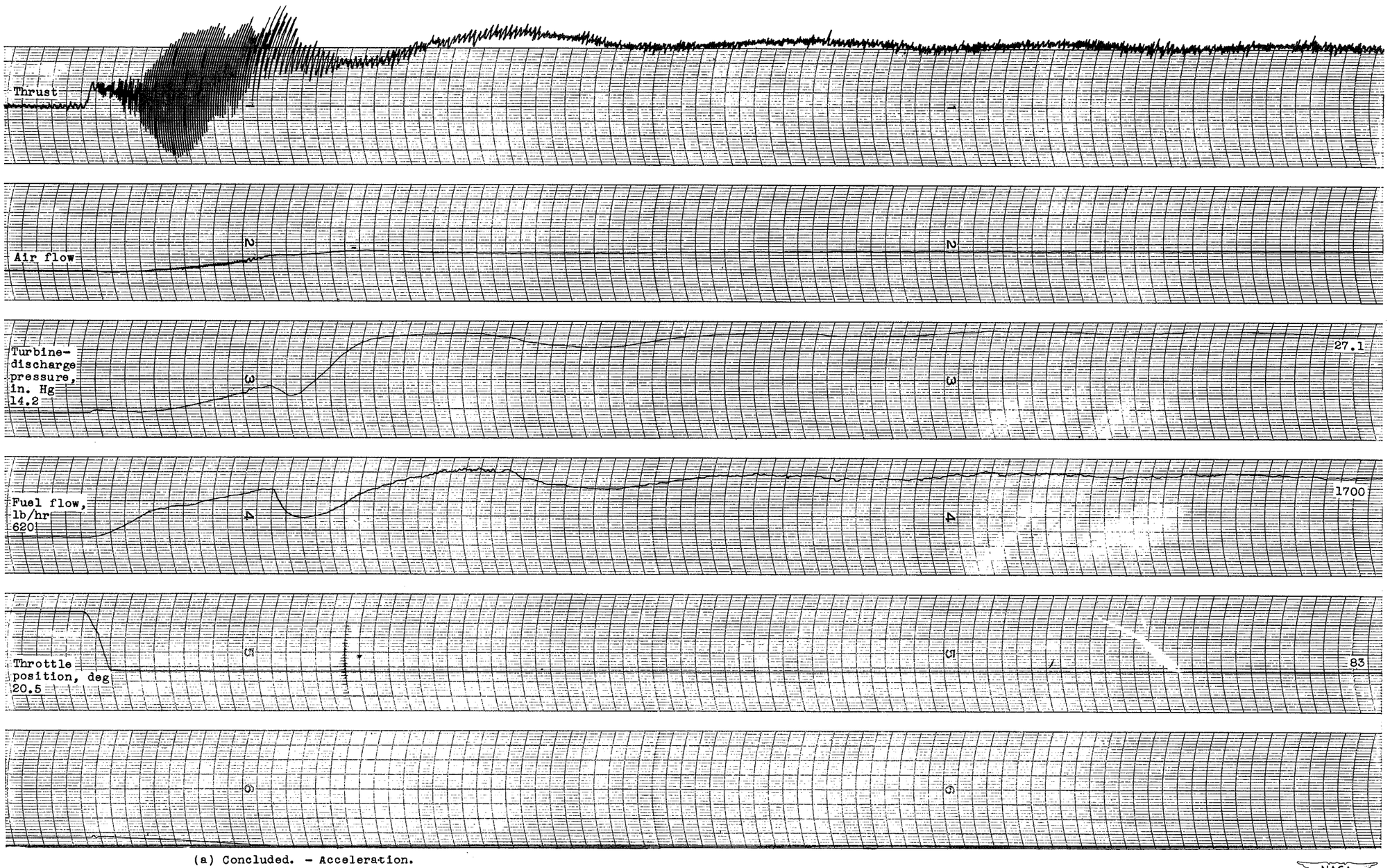
(b) Concluded. - Deceleration.

Figure 35. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 20.5° to 35°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



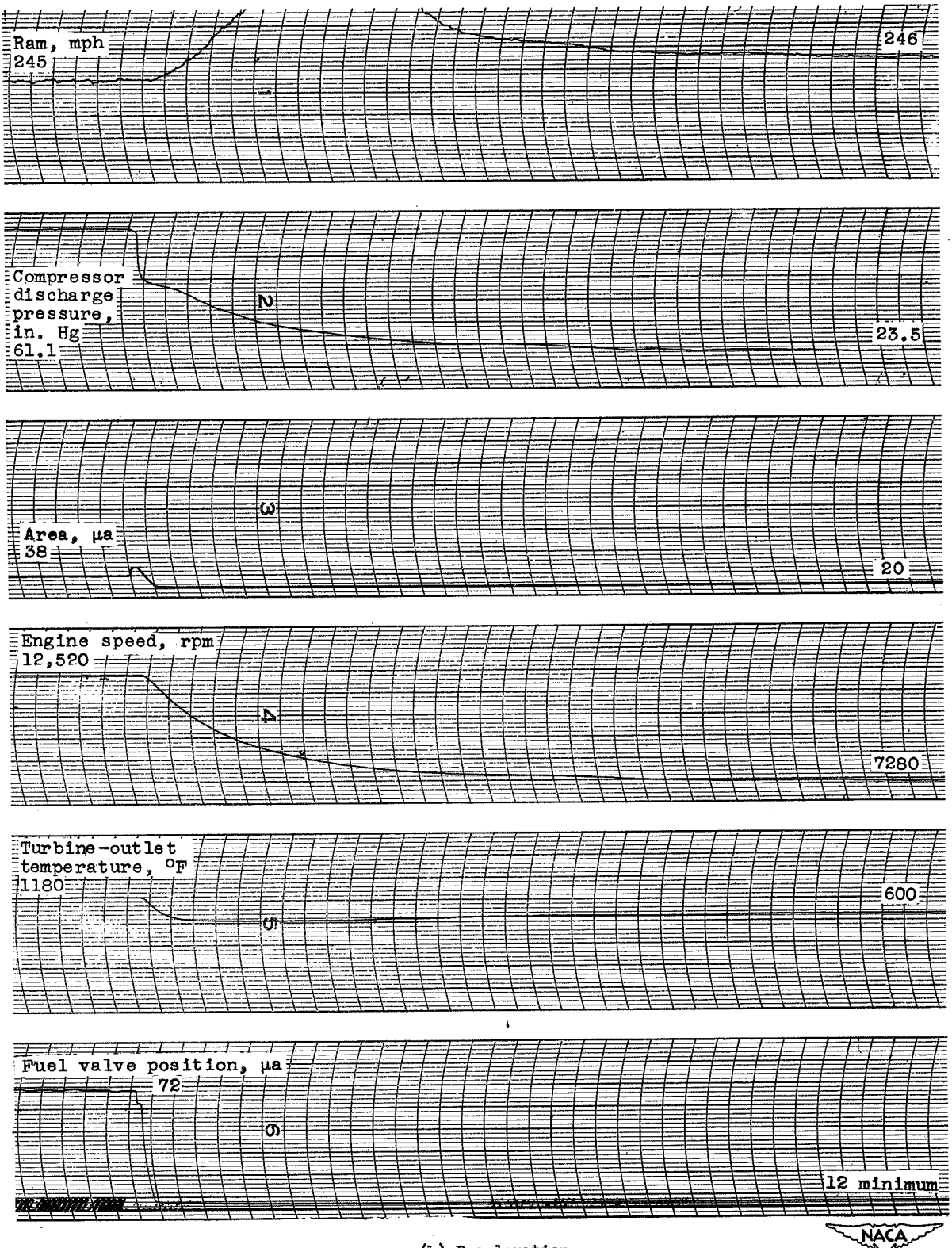
(a) Acceleration.

Figure 36. - Transient operation of automatically-controlled engine. Throttle position, 20.5° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



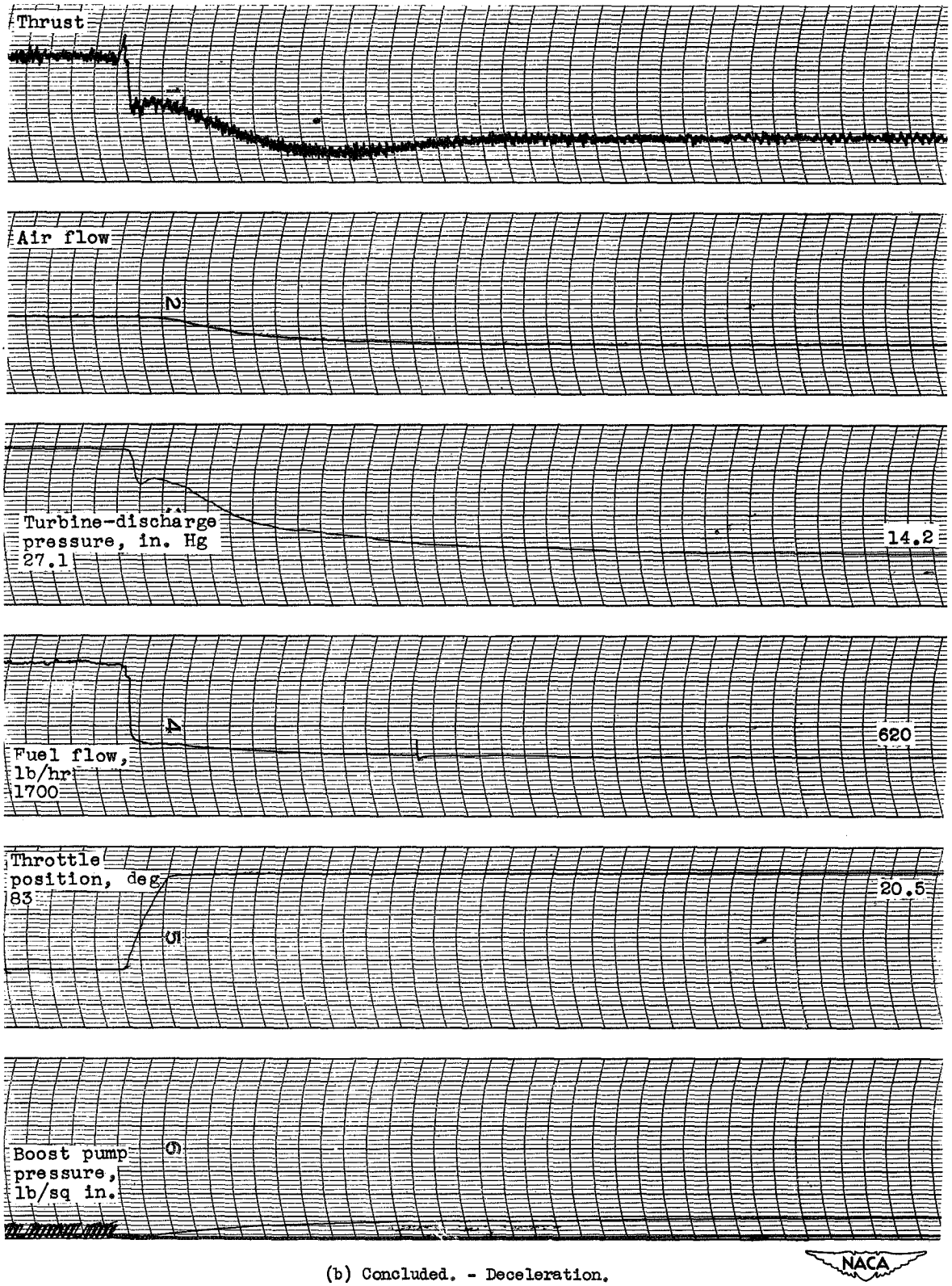
(a) Concluded. - Acceleration.

Figure 36. - Continued. Transient operation of automatically-controlled engine. Throttle position, 20.5° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



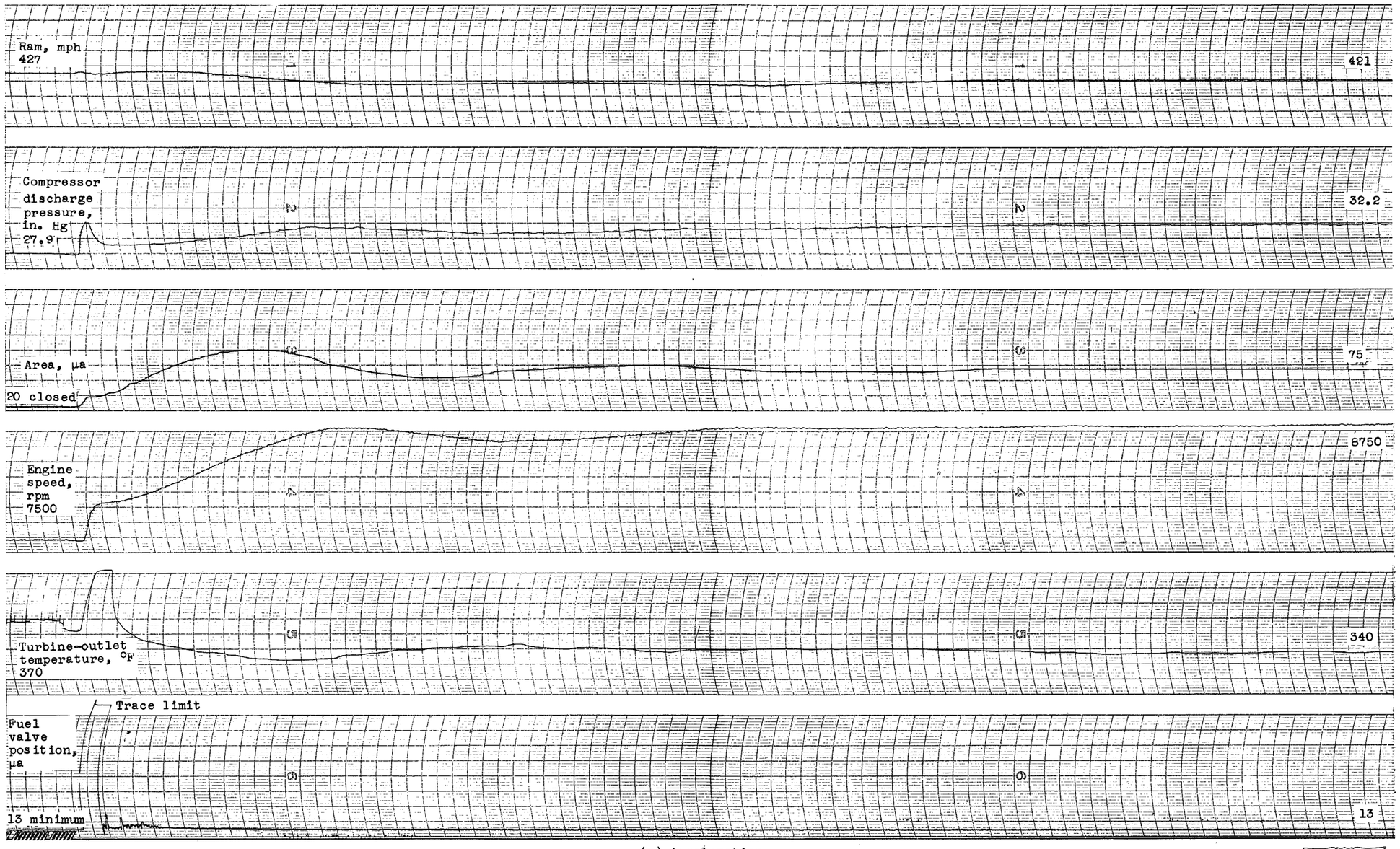
(b) Deceleration.

Figure 36. - Continued. Transient operation of automatically-controlled engine. Throttle position, 20.5° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



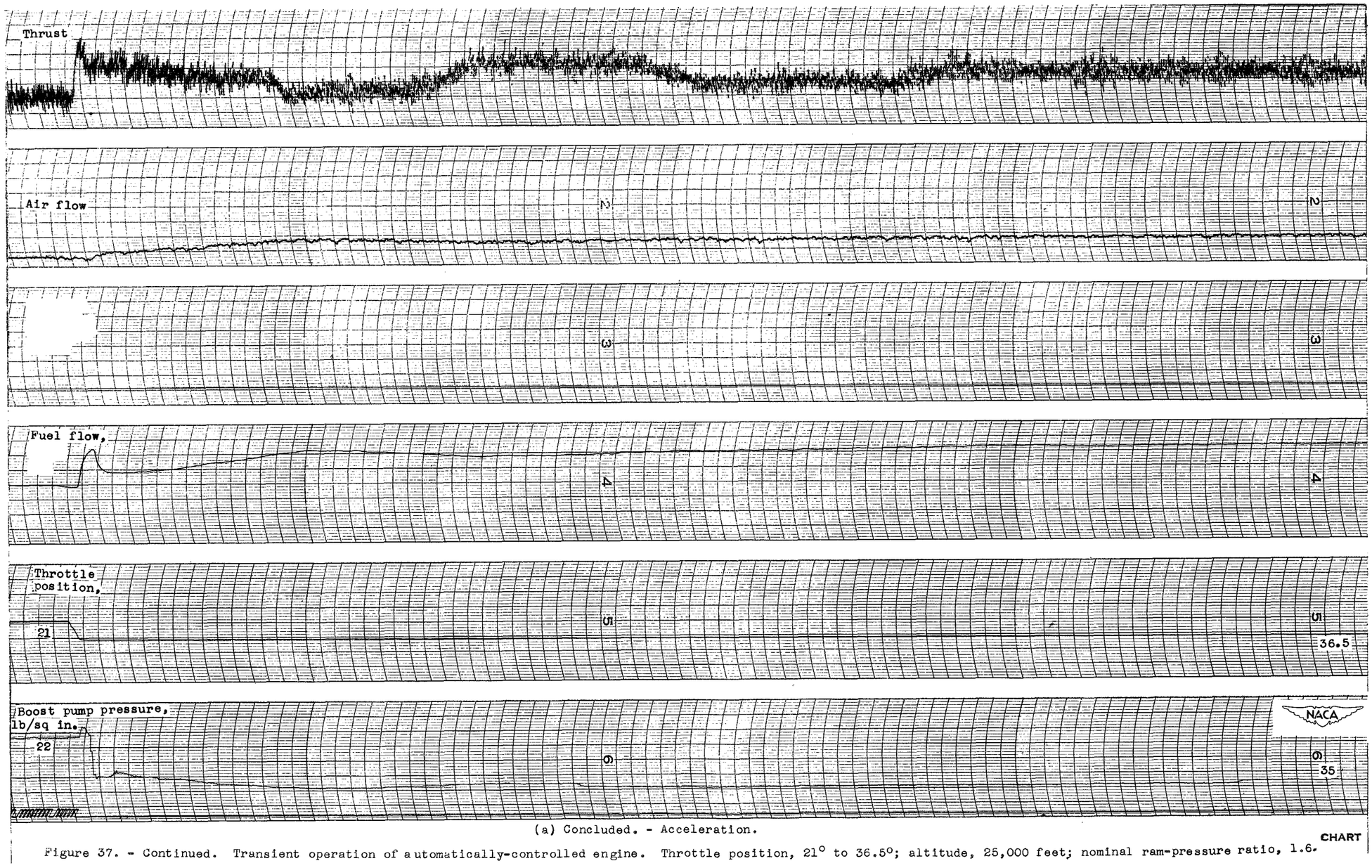
(b) Concluded. - Deceleration.

Figure 36. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 20.5° to 83°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.2.



(a) Acceleration.

Figure 37. - Transient operation of automatically-controlled engine. Throttle position, 21° to 36.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



(a) Concluded. - Acceleration.

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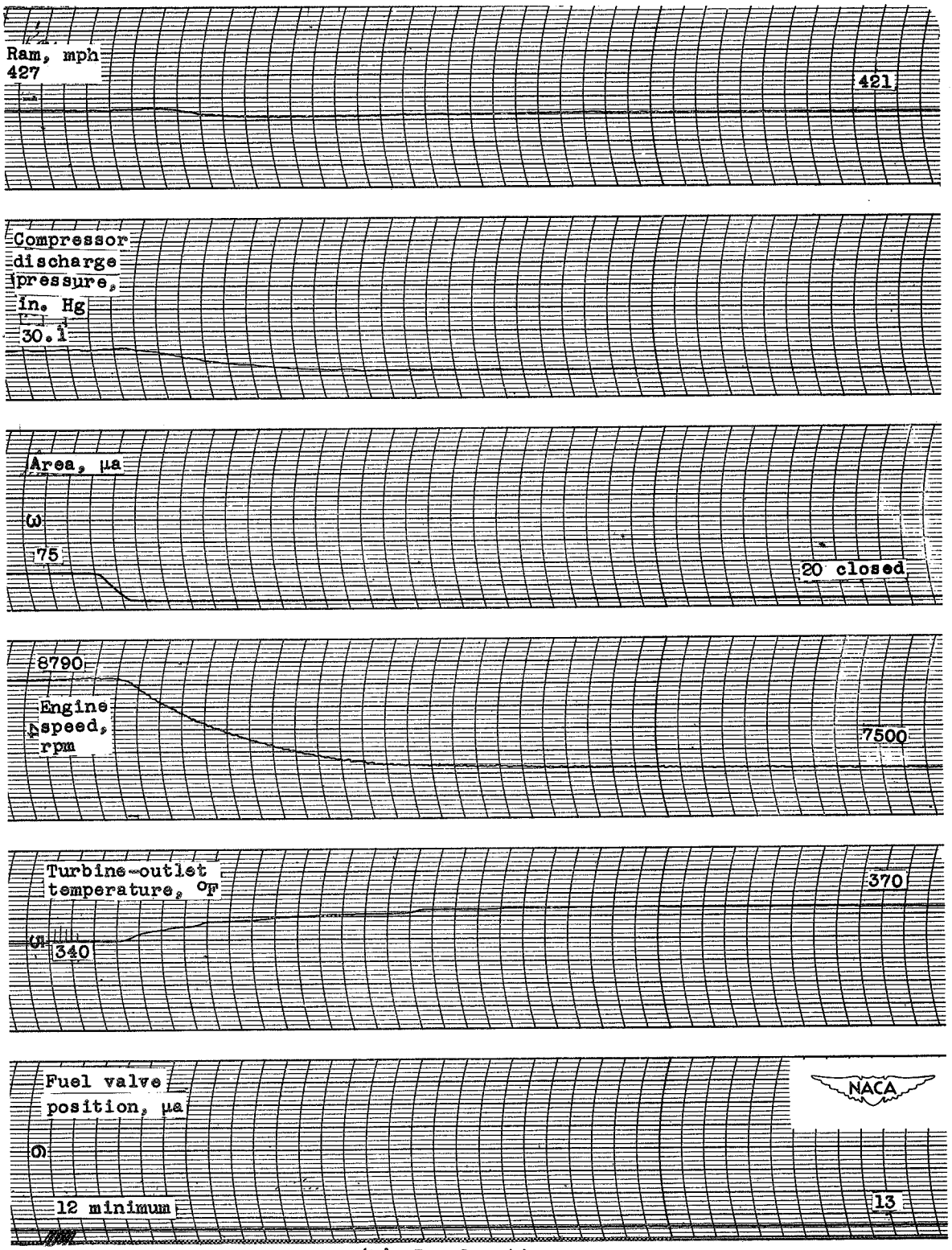
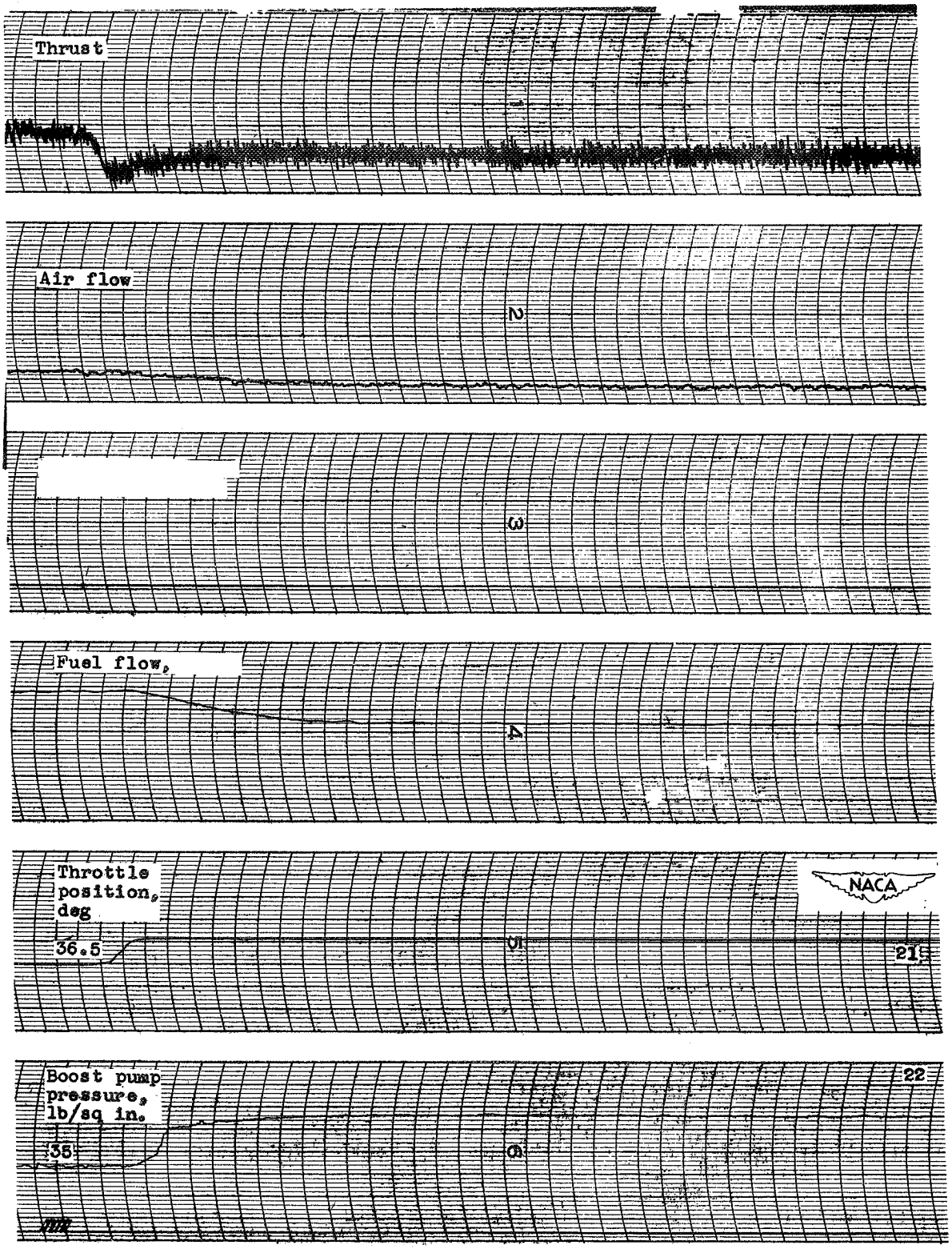
Figure 37. - Continued. Transient operation of automatically-controlled engine. Throttle position, 21° to 36.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



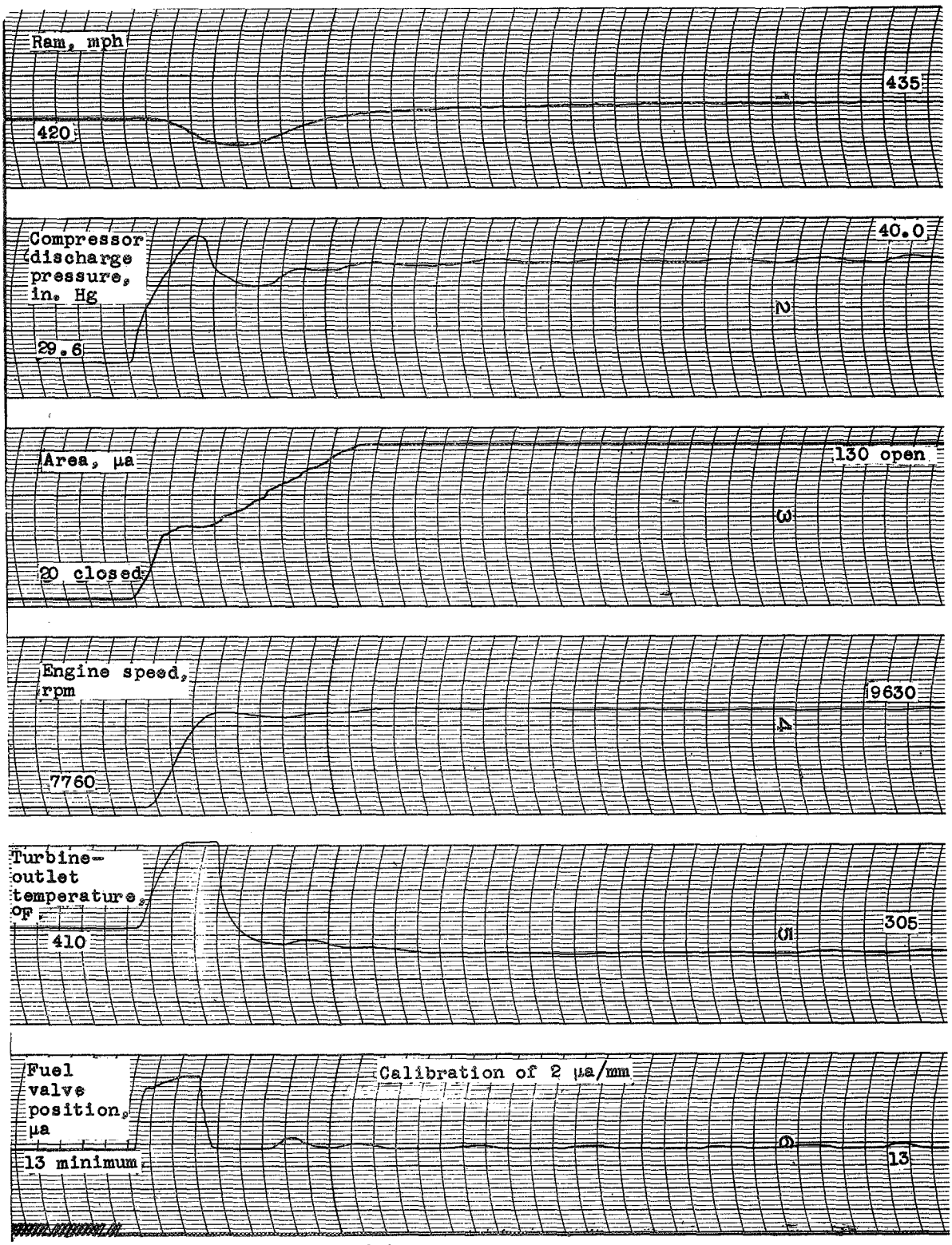
(b) Deceleration.

Figure 37. - Continued. Transient operation of automatically-controlled engine. Throttle position, 21° to 36.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



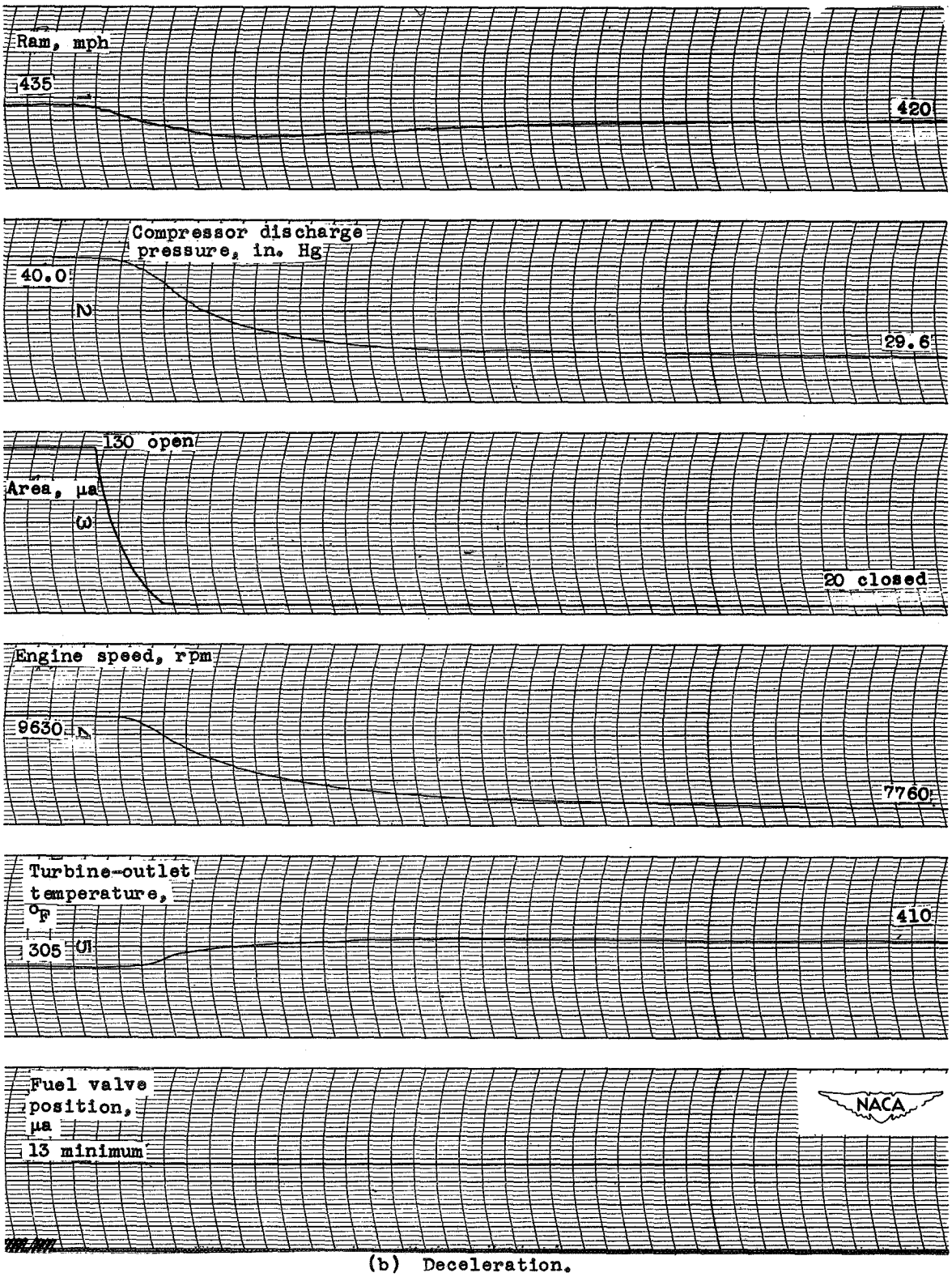
(b) Concluded. Deceleration.

Figure 37. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 21° to 36.5°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



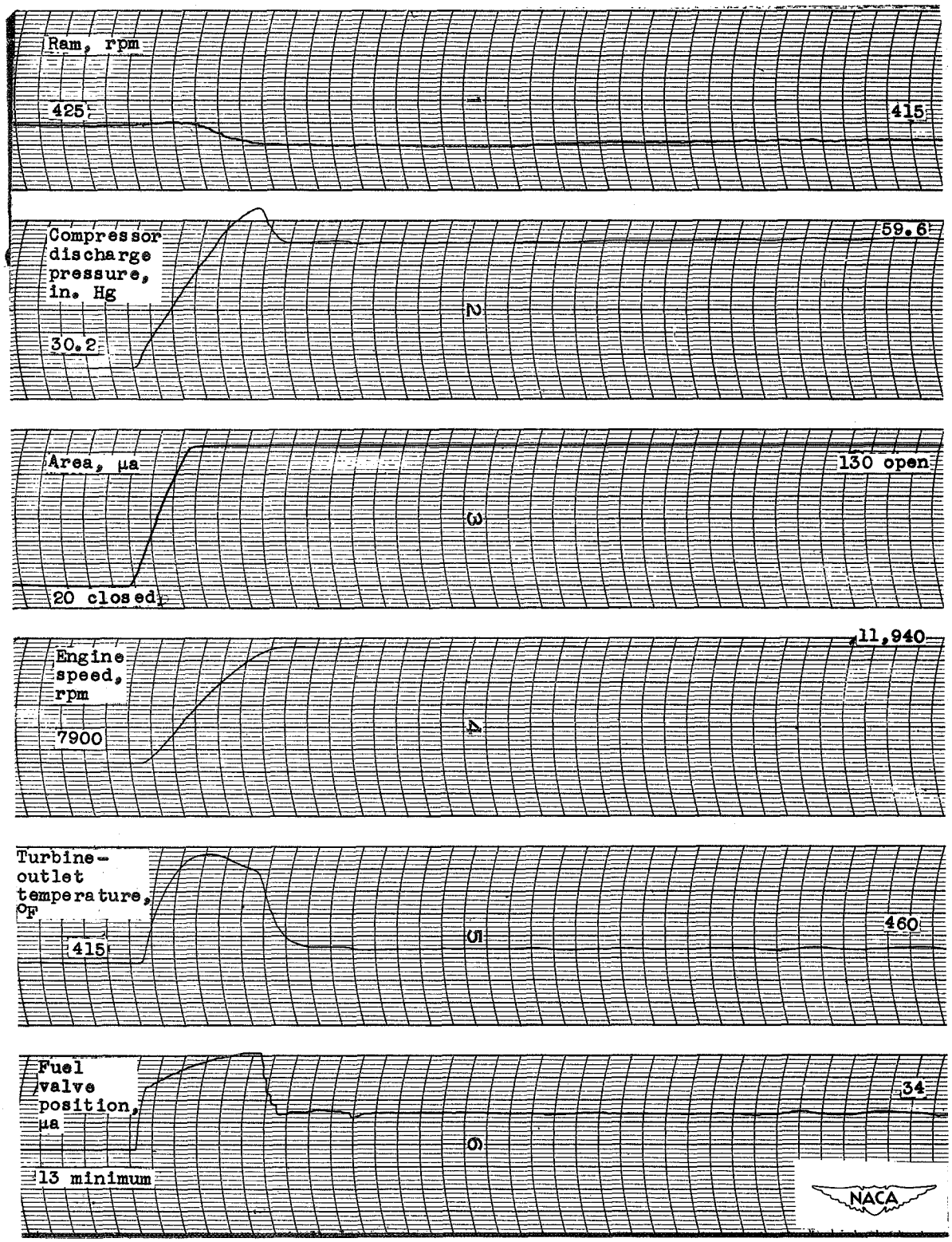
(a) Acceleration.

Figure 38. - Transient operation of automatically-controlled engine. Throttle position, 33° to 41°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



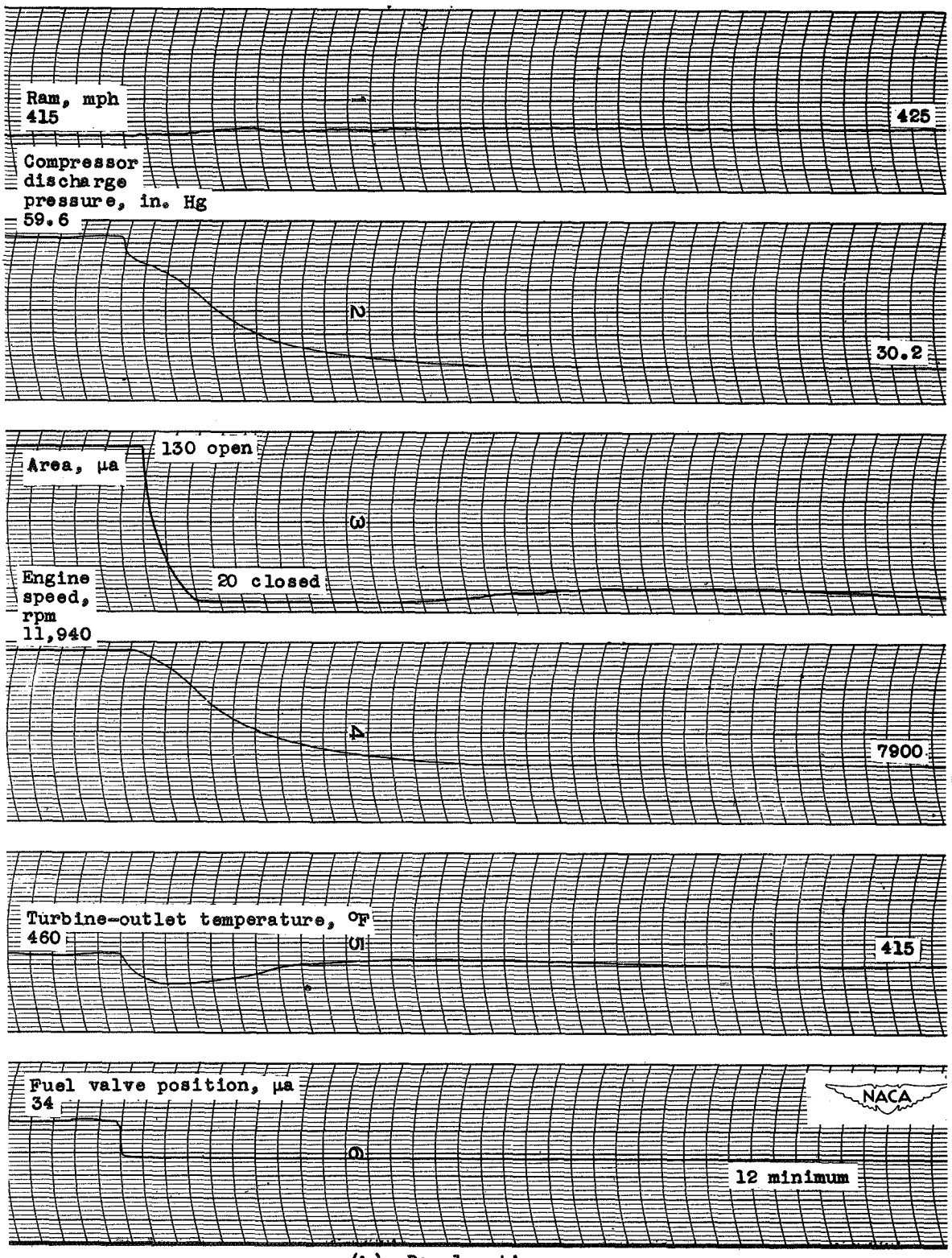
(b) Deceleration.

Figure 38. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 33° to 41°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



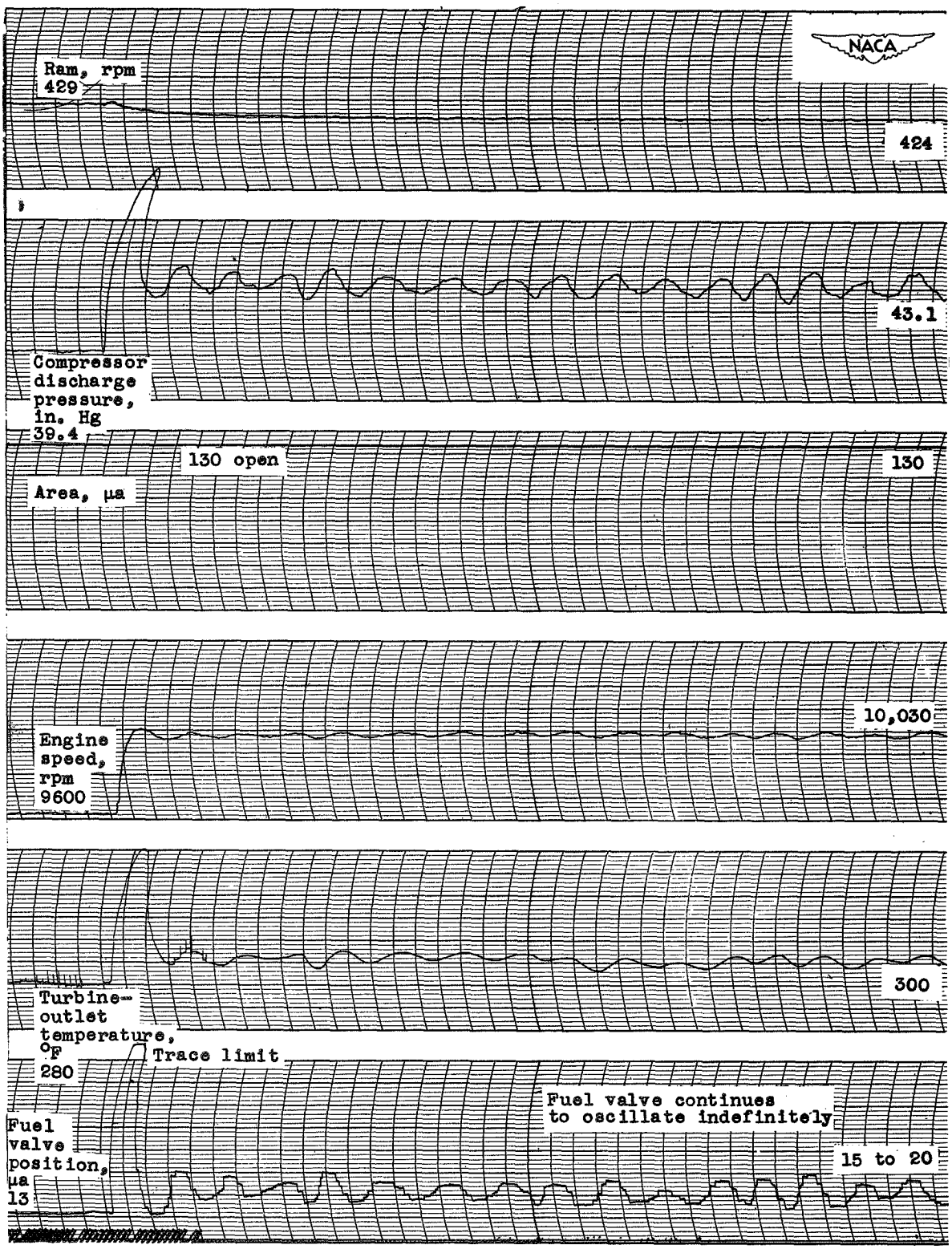
(a) Acceleration.

Figure 39. - Transient operation of automatically-controlled engine. Throttle position 33° to 62°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



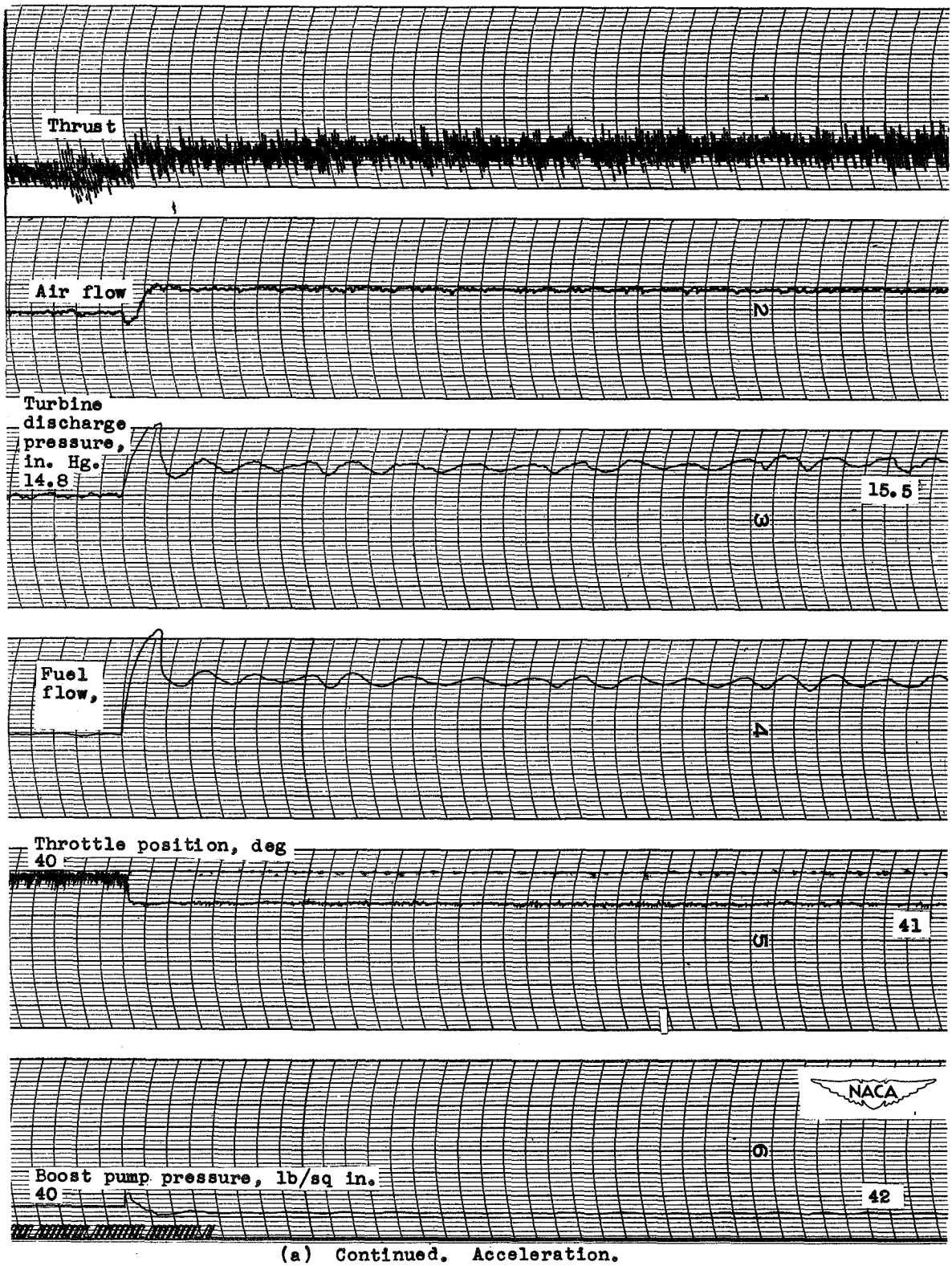
(b) Deceleration.

Figure 39. - Continued. Transient operation of automatically-controlled engine. Throttle position, 33° to 62°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



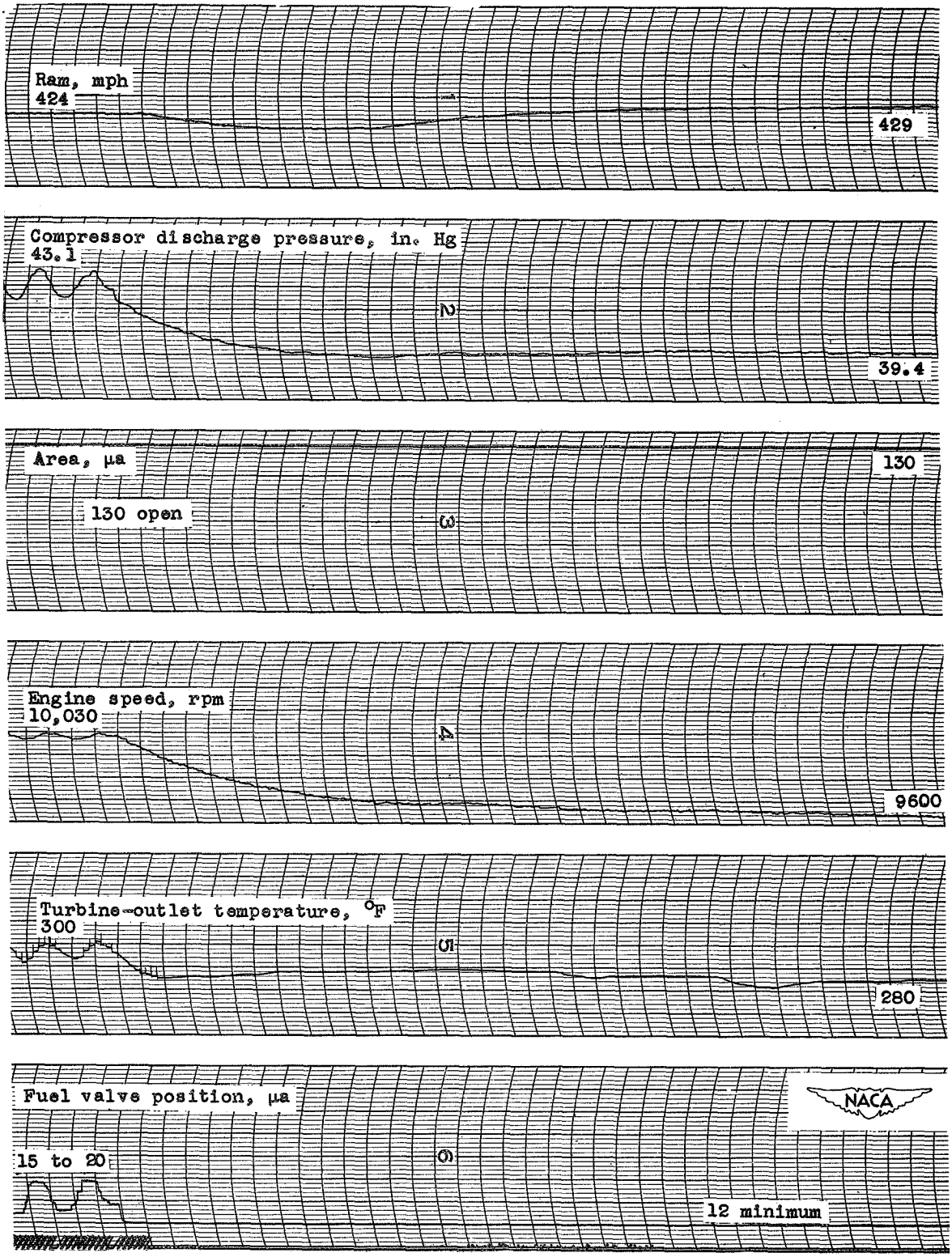
(a) Acceleration.

Figure 40. - Transient operation of automatically-controlled engine. Throttle position, 40° to 41°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



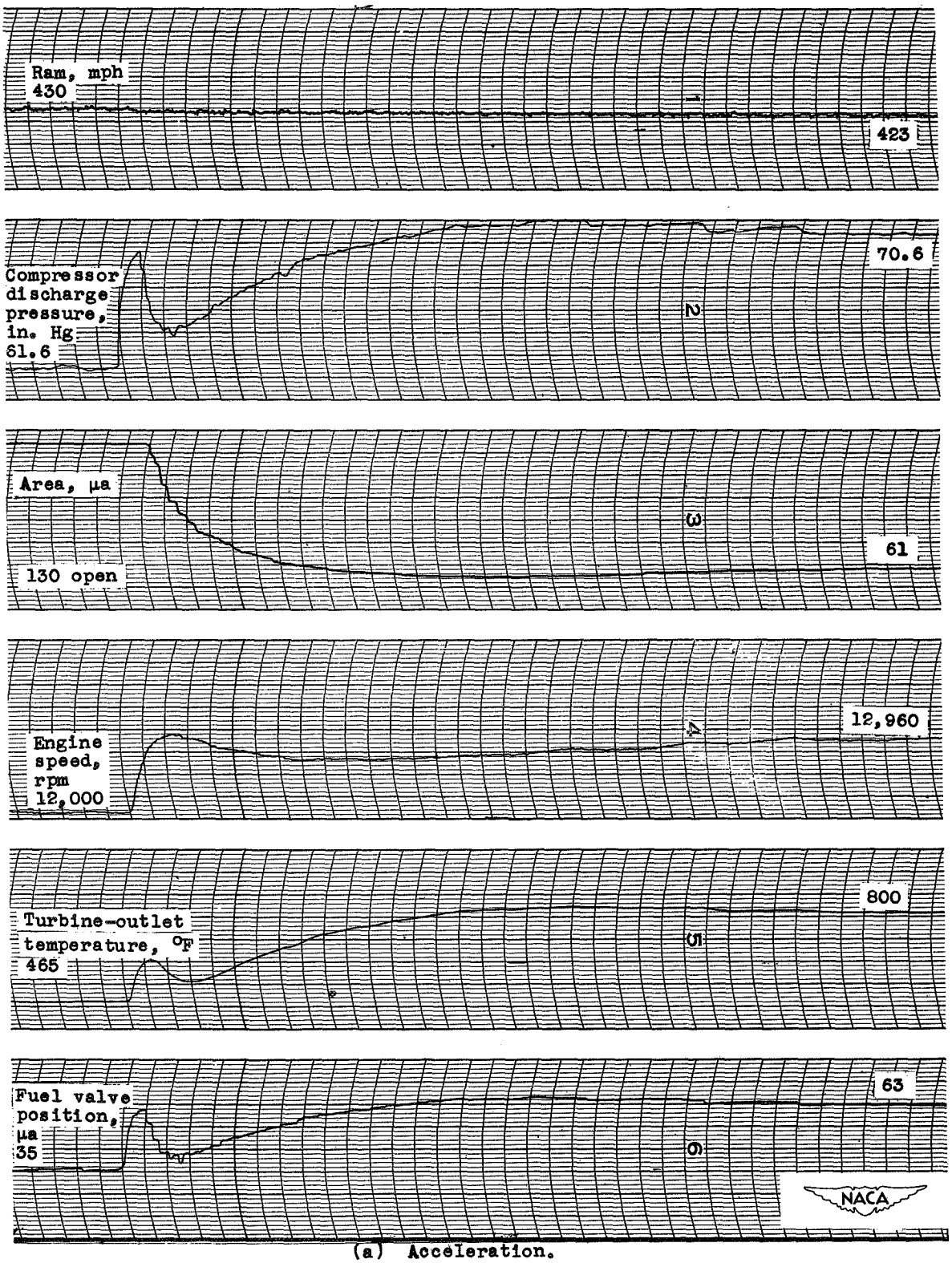
(a) Continued. Acceleration.

Figure 40. - Continued. Transient operation of automatically-controlled engine. Throttle position, 40° to 41°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



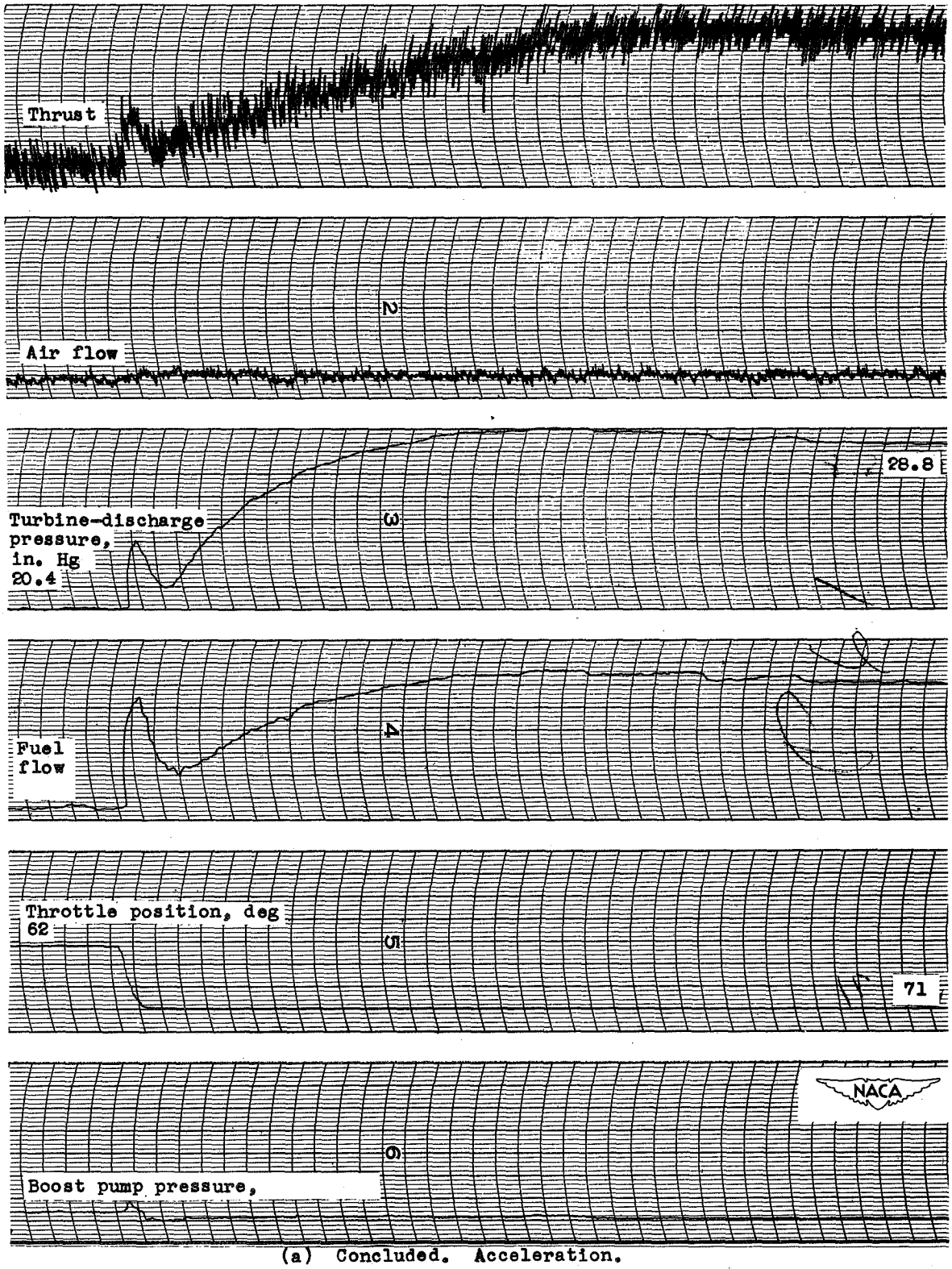
(b) Deceleration.

Figure 40. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 40° to 41°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



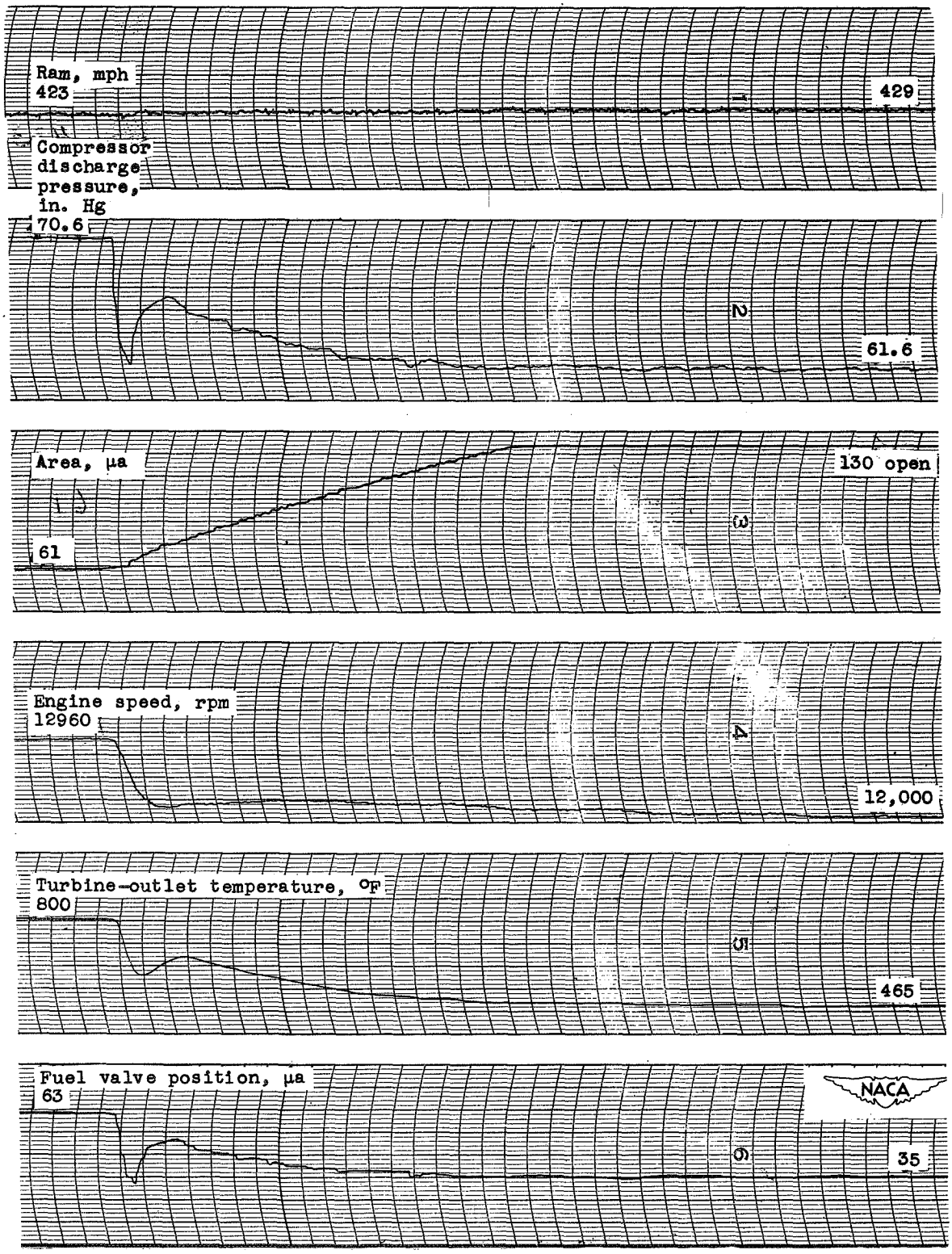
(a) Acceleration.

Figure 41. - Transient operation of automatically-controlled engine. Throttle position 62° to 71°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



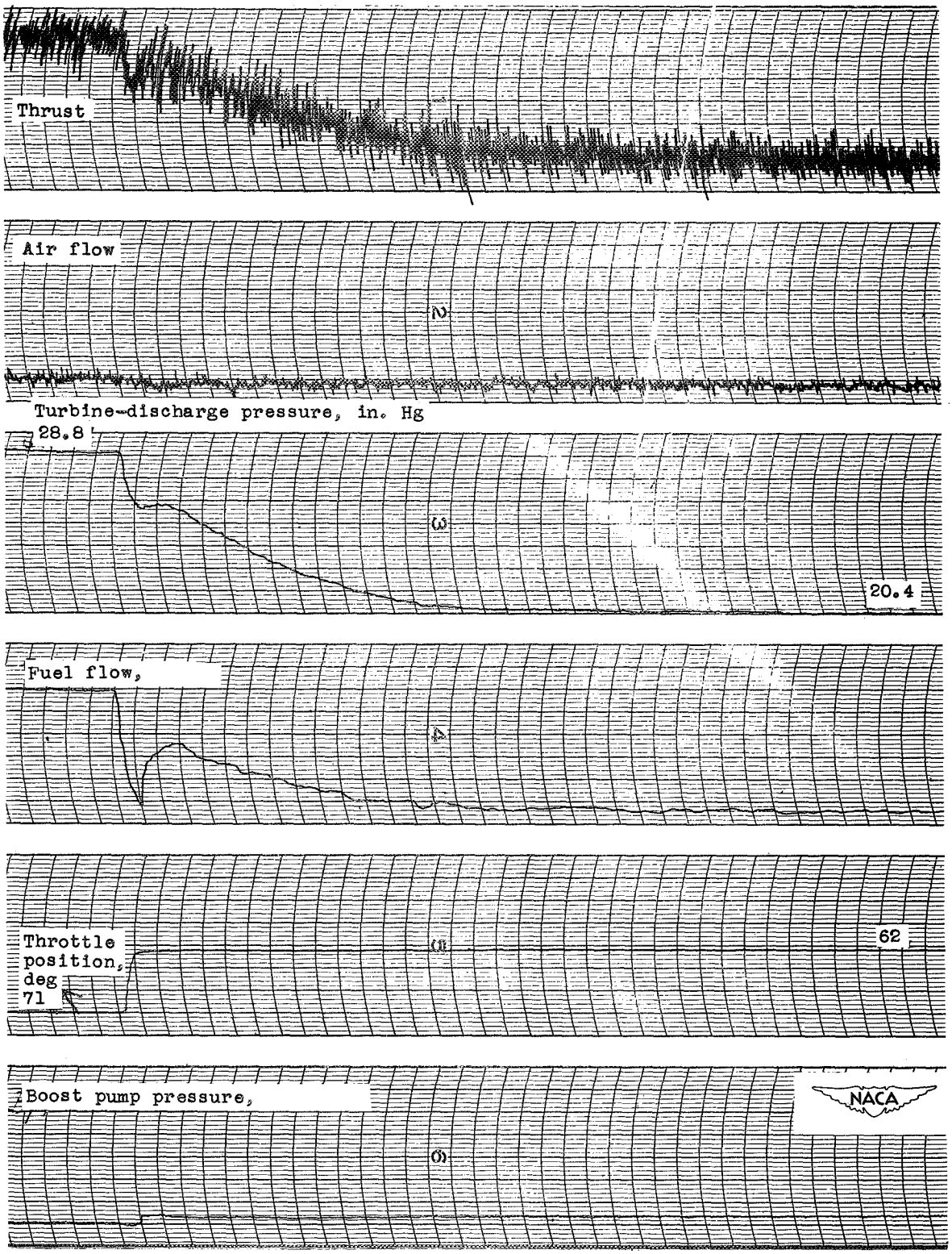
(a) Concluded. Acceleration.

Figure 41. - Continued. Transient operation of automatically-controlled engine. Throttle position 62° to 71°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



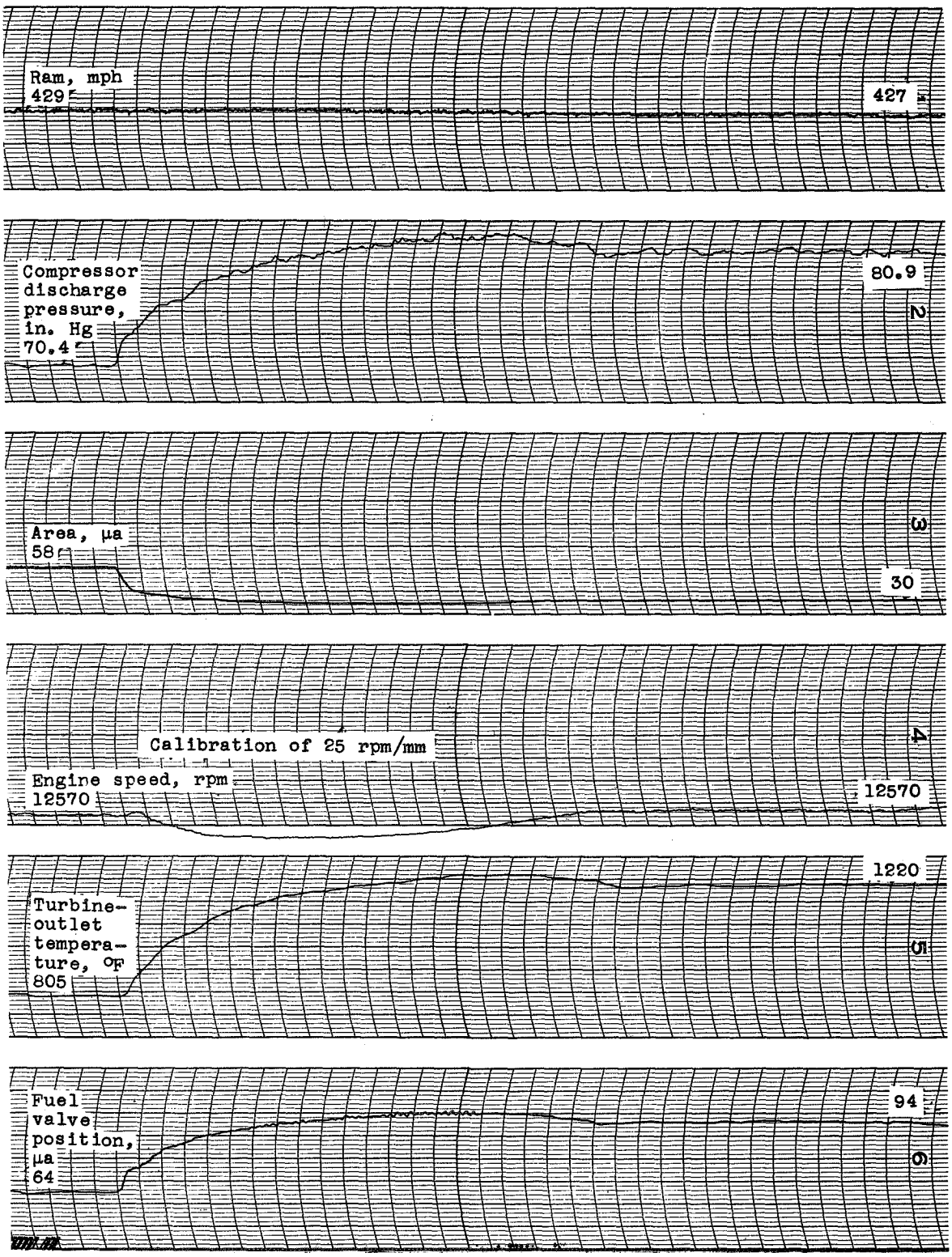
(b) Deceleration.

Figure 41. - Continued. Transient operation of automatically-controlled engine. Throttle position, 62° to 71°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



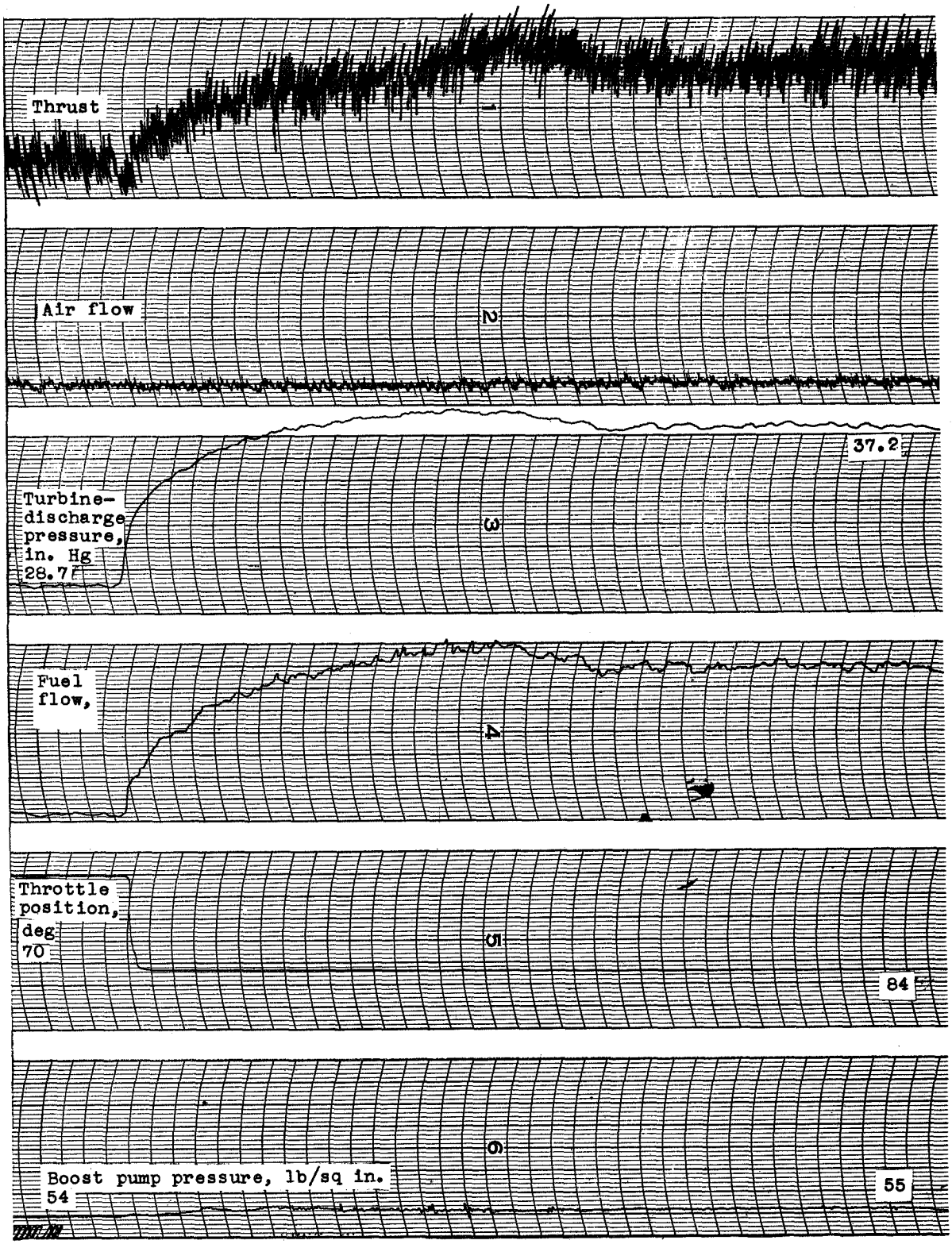
(b) Concluded. Deceleration.

Figure 41. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 62° to 71°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



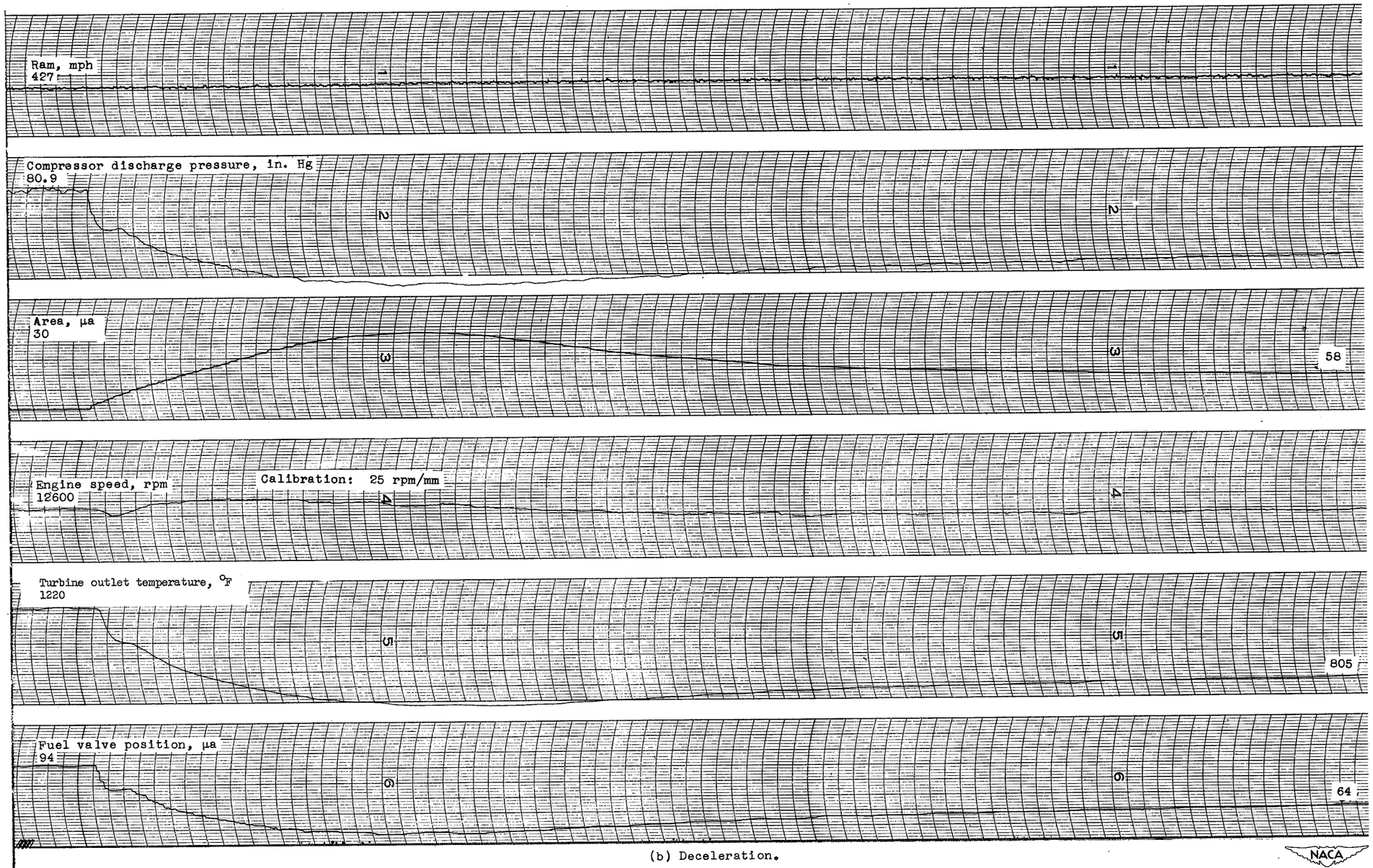
(a) Acceleration.

Figure 42. - Transient operation of automatically-controlled engine. Throttle position, 70° to 84°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



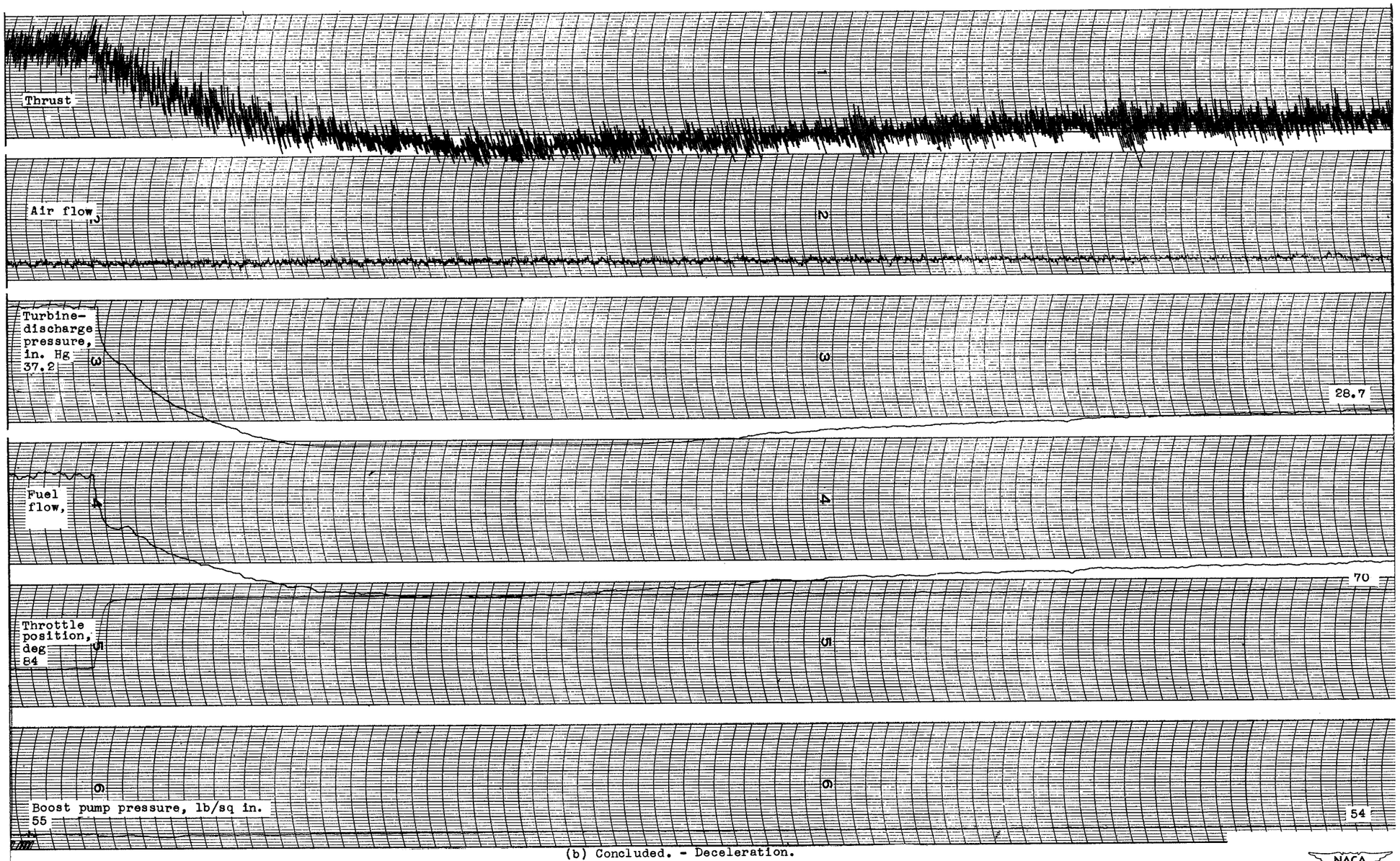
(a) Concluded. Acceleration.

Figure 42. - Continued. Transient operation of automatically-controlled engine. Throttle position, 70° to 84°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



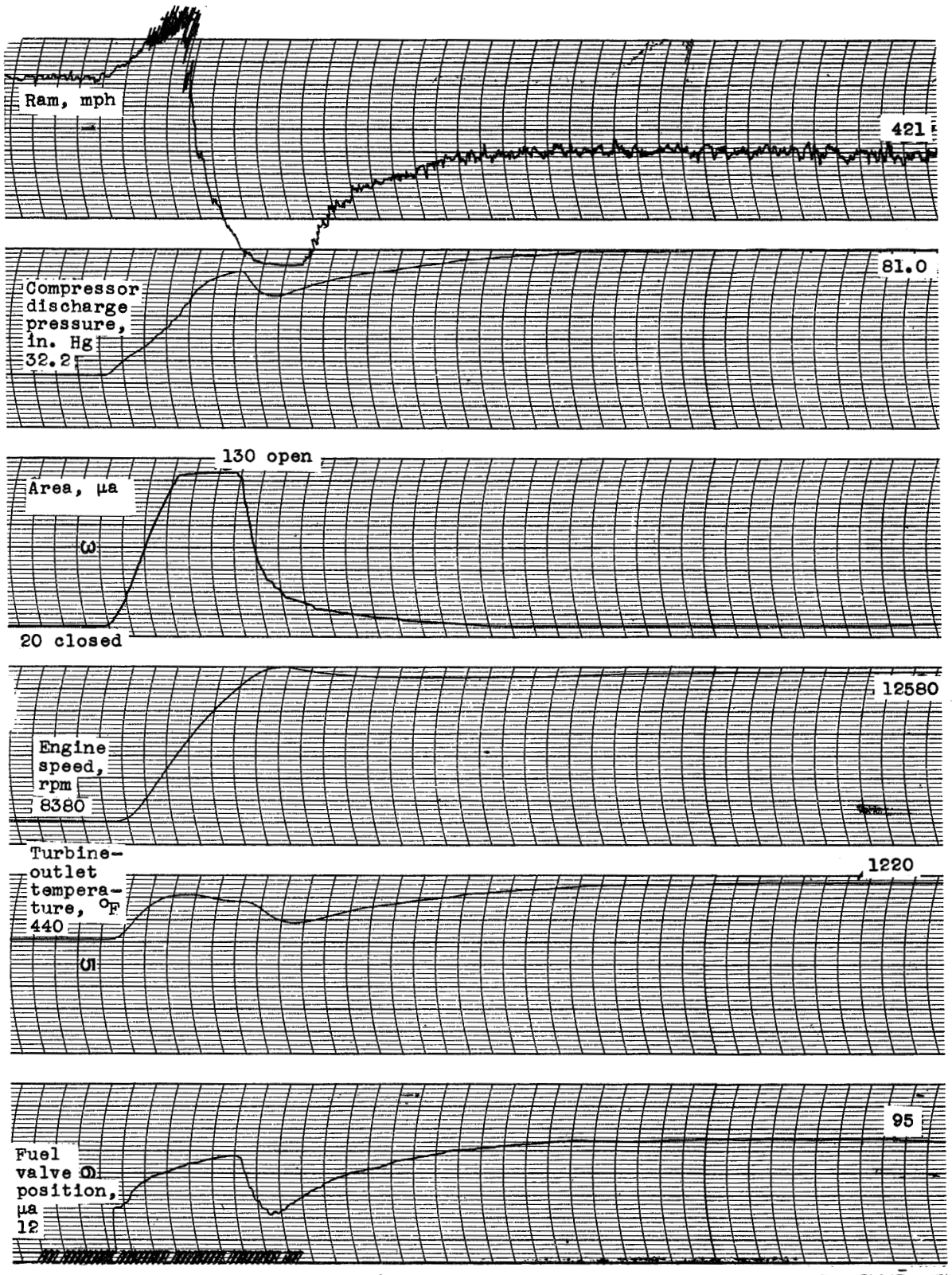
(b) Deceleration.

Figure 42. - Continued. Transient operation of automatically-controlled engine. Throttle position, 70° to 84°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



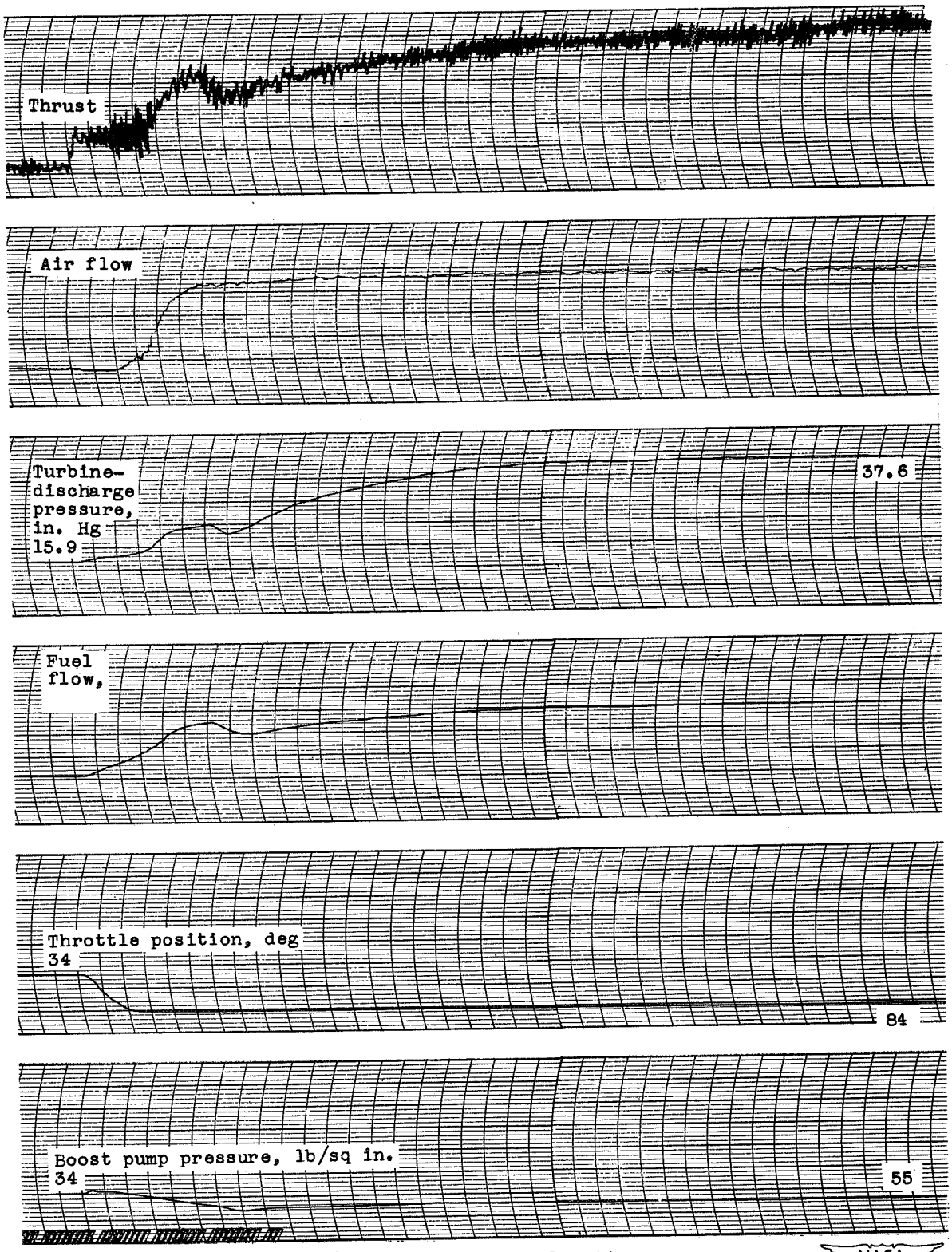
(b) Concluded. - Deceleration.

Figure 42. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 70° to 84°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



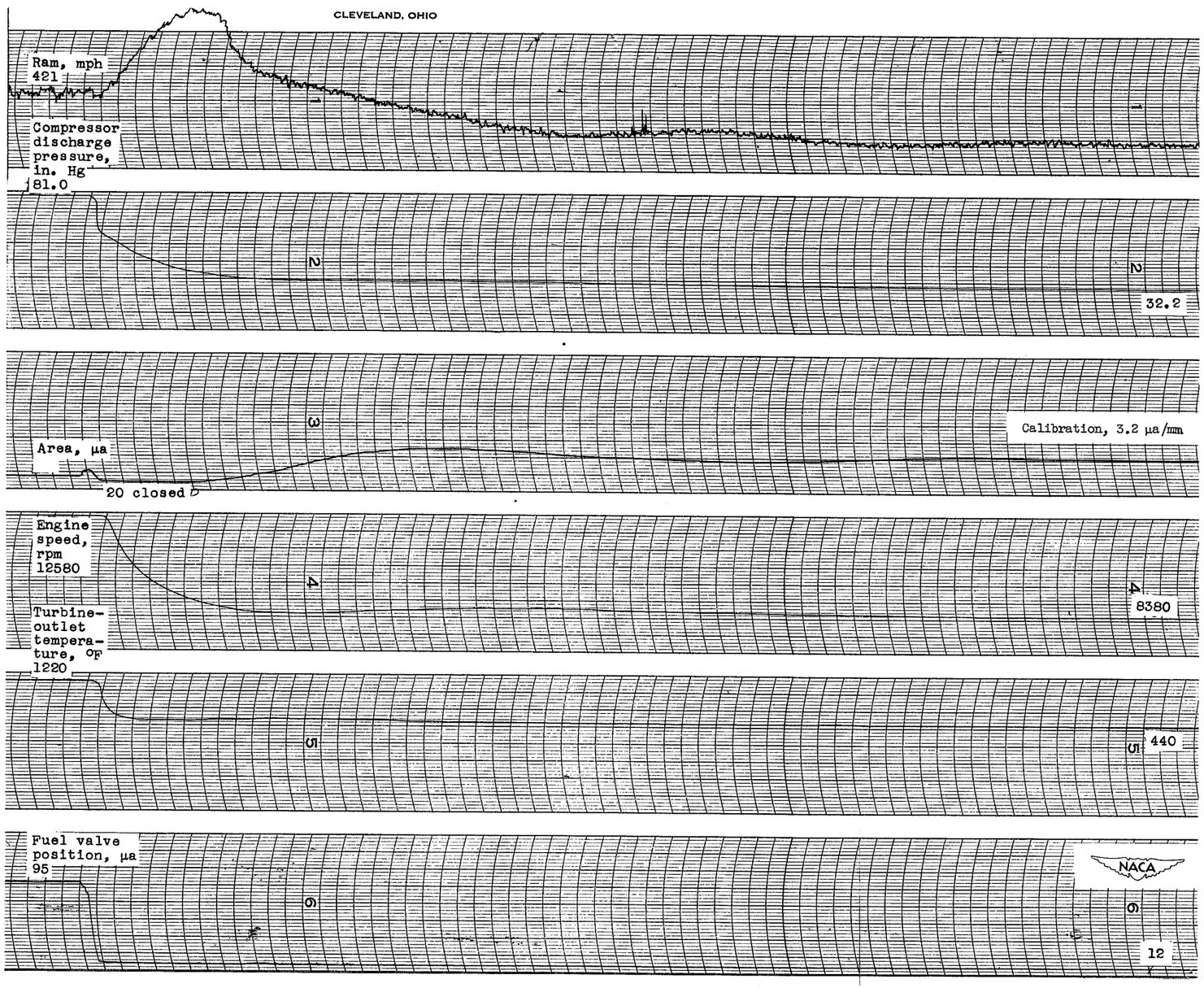
(a) Acceleration.

Figure 43. - Transient operation of automatically-controlled engine. Throttle position, 34 to 84 ; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



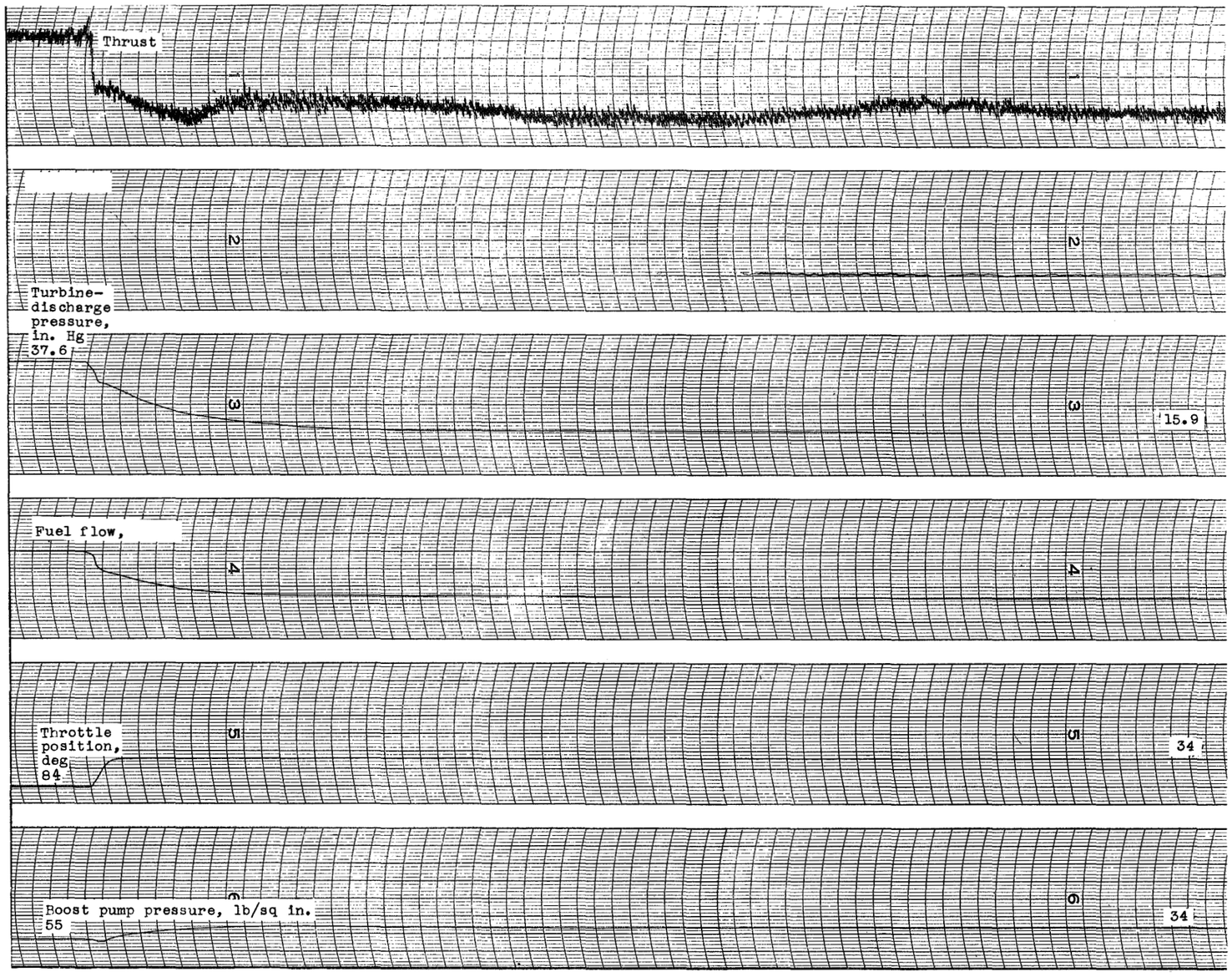
(a) Continued. Acceleration.

Figure 43. - Continued. Transient operation of automatically-controlled engine. Throttle position, 34 to 84 ; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



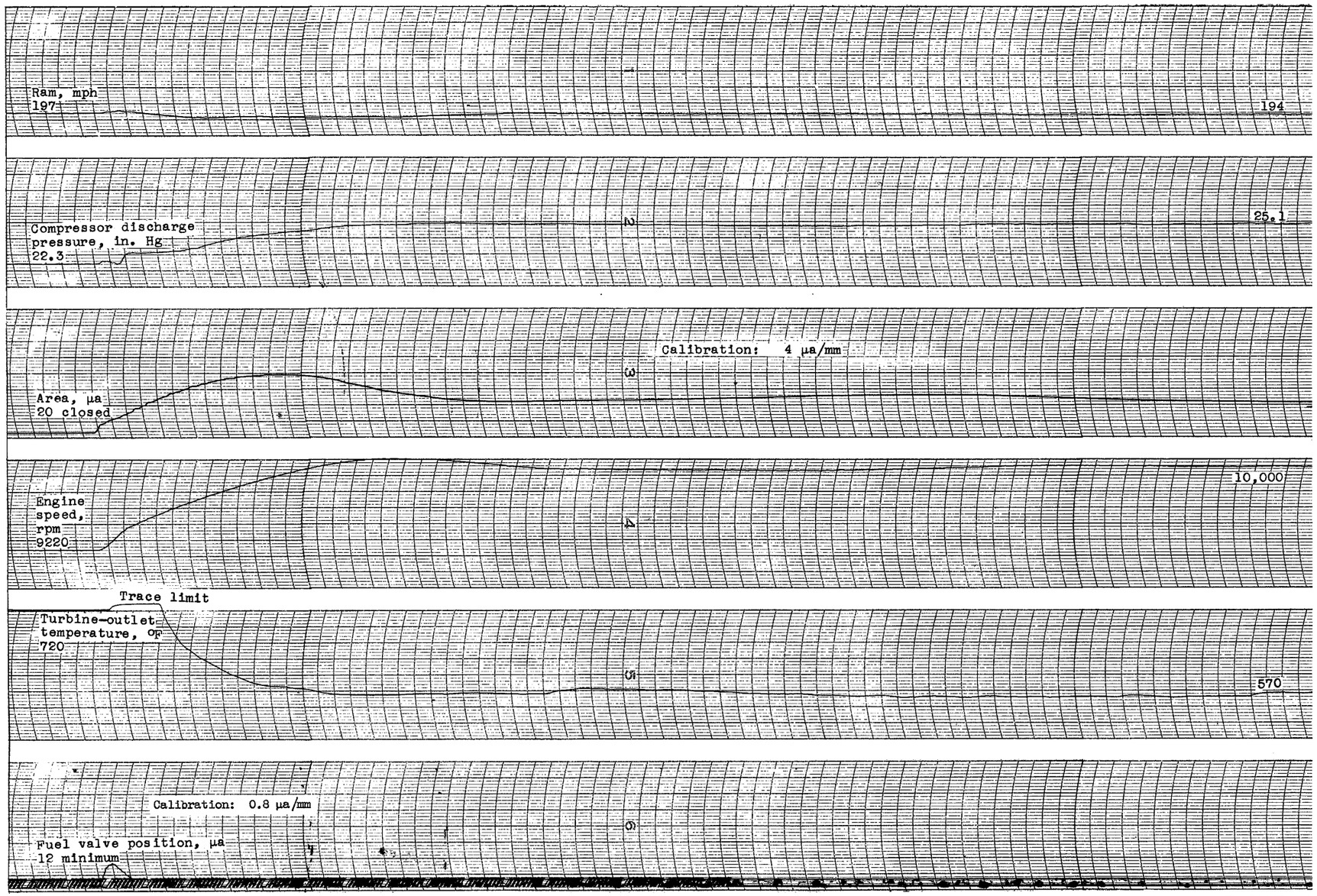
(b) Deceleration.

Figure 43. - Continued. Transient operation of automatically-controlled engine. Throttle position, 34° to 84°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



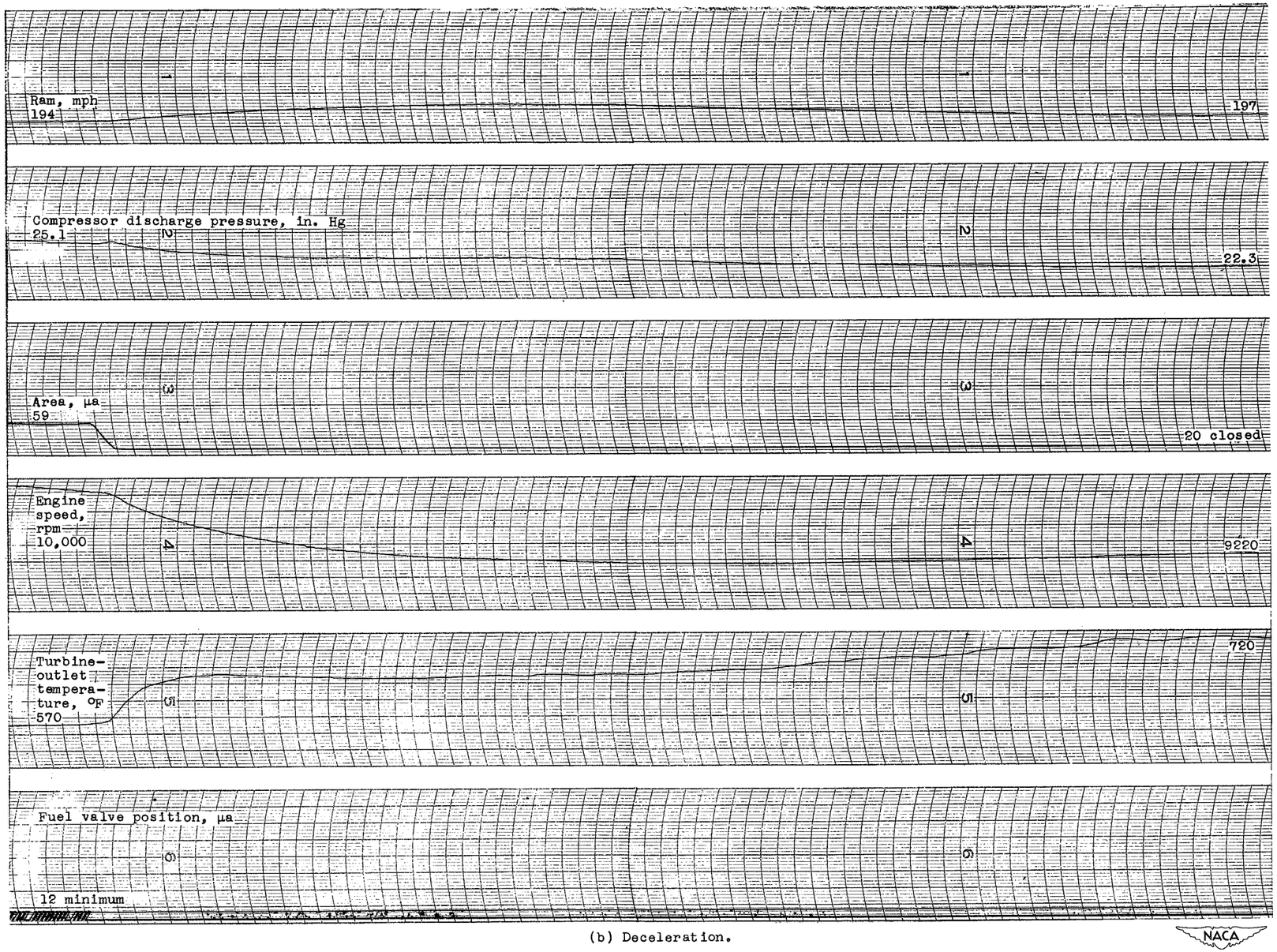
(b) Concluded. - Deceleration.

Figure 43. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 34° to 84°; altitude, 25,000 feet; nominal ram-pressure ratio, 1.6.



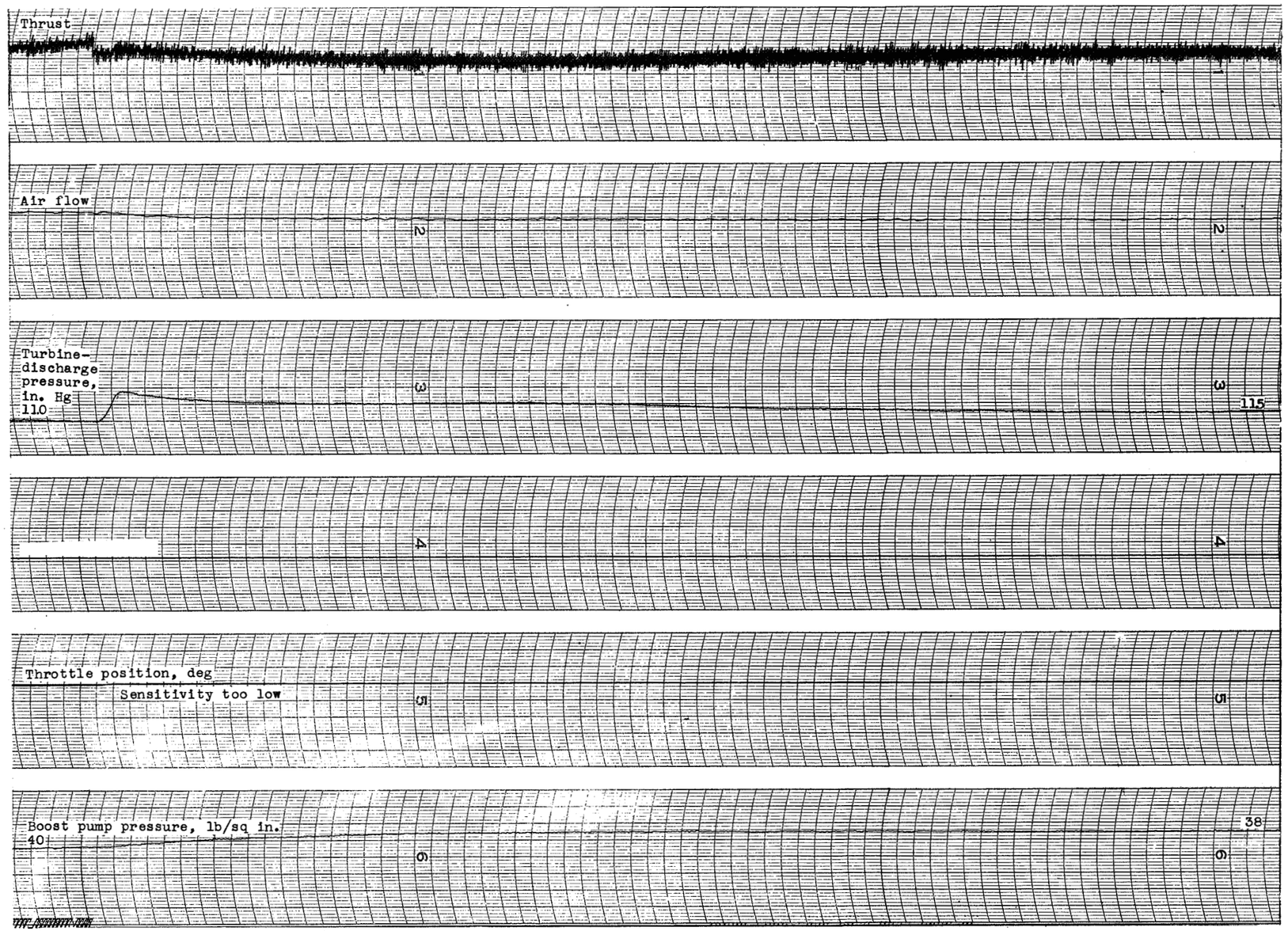
(a) Acceleration.

Figure 44. - Transient operation of automatically-controlled engine. Throttle position, 37° to 40°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 44. - Continued. Transient operation of automatically-controlled engine. Throttle position, 37° to 40°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 44. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 37° to 40°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.

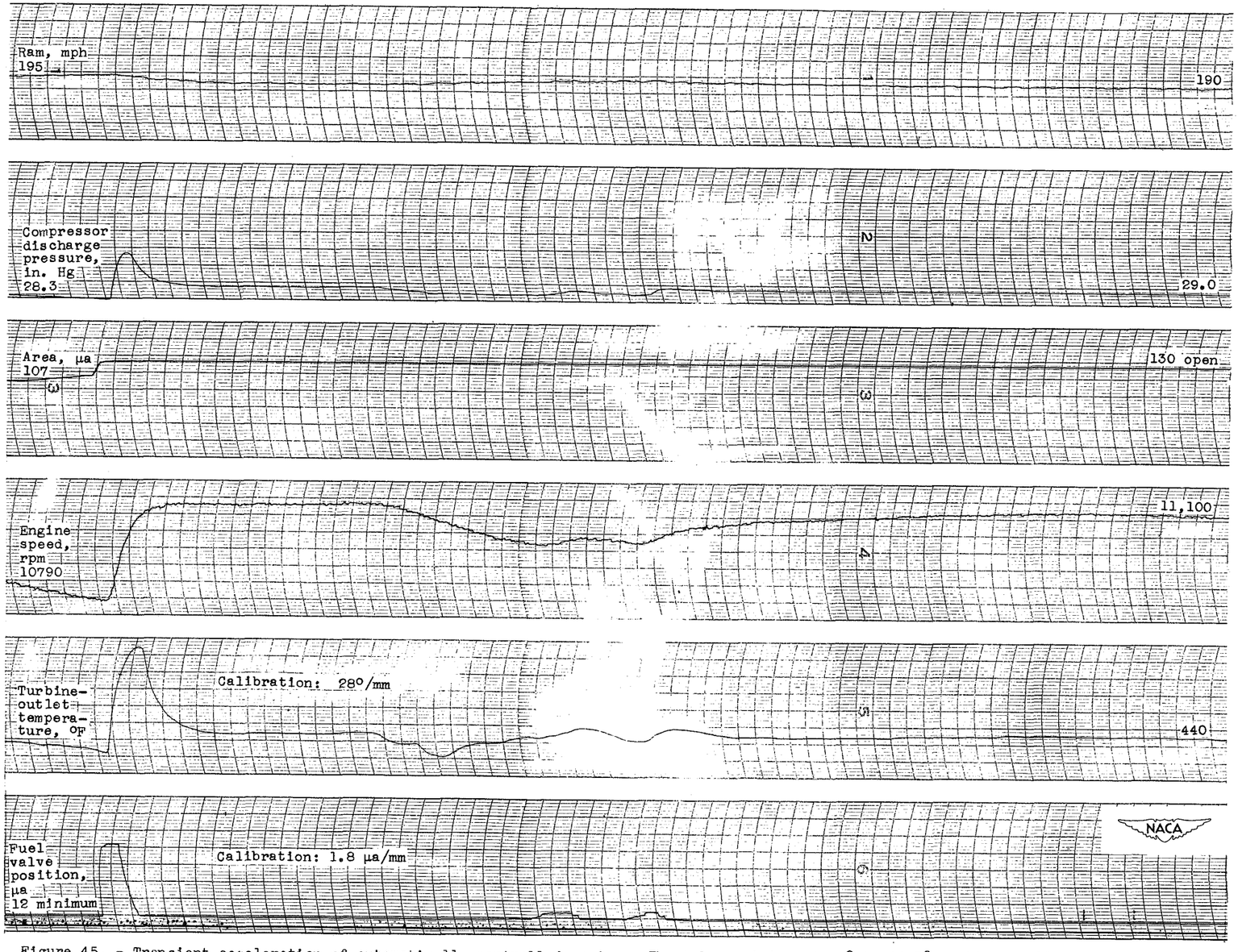
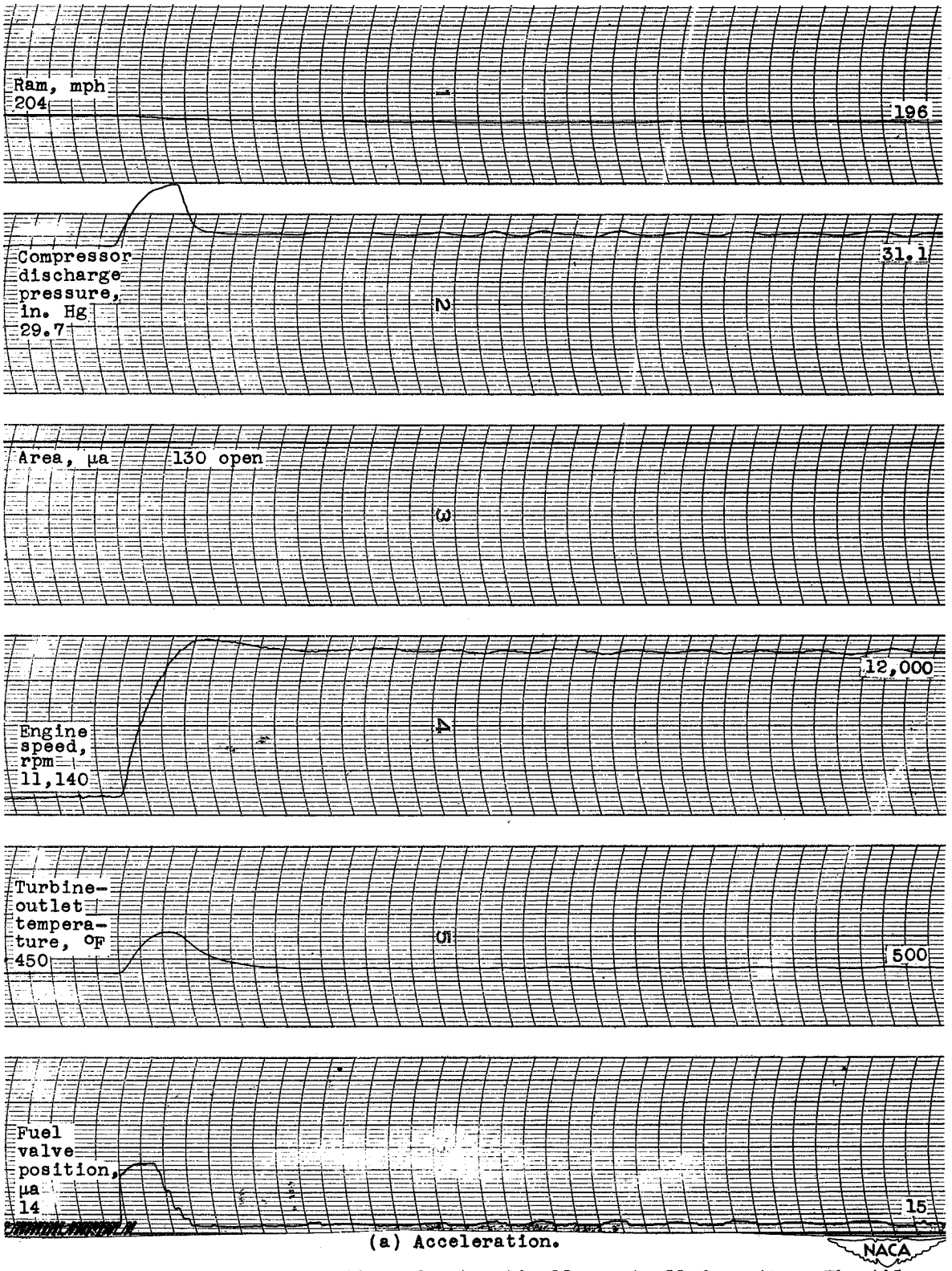
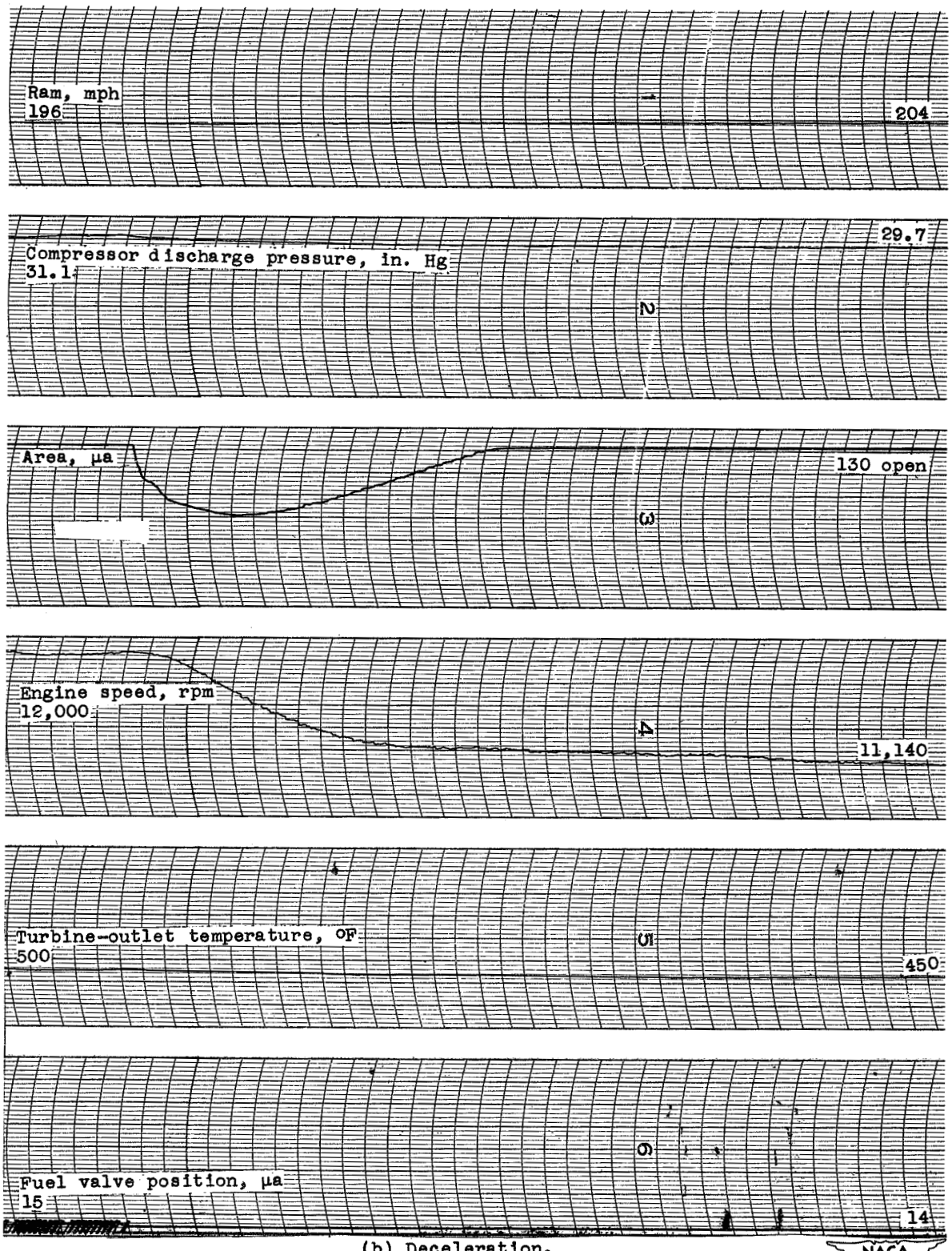


Figure 45. - Transient acceleration of automatically-controlled engine. Throttle position, 41.5° to 44.5°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



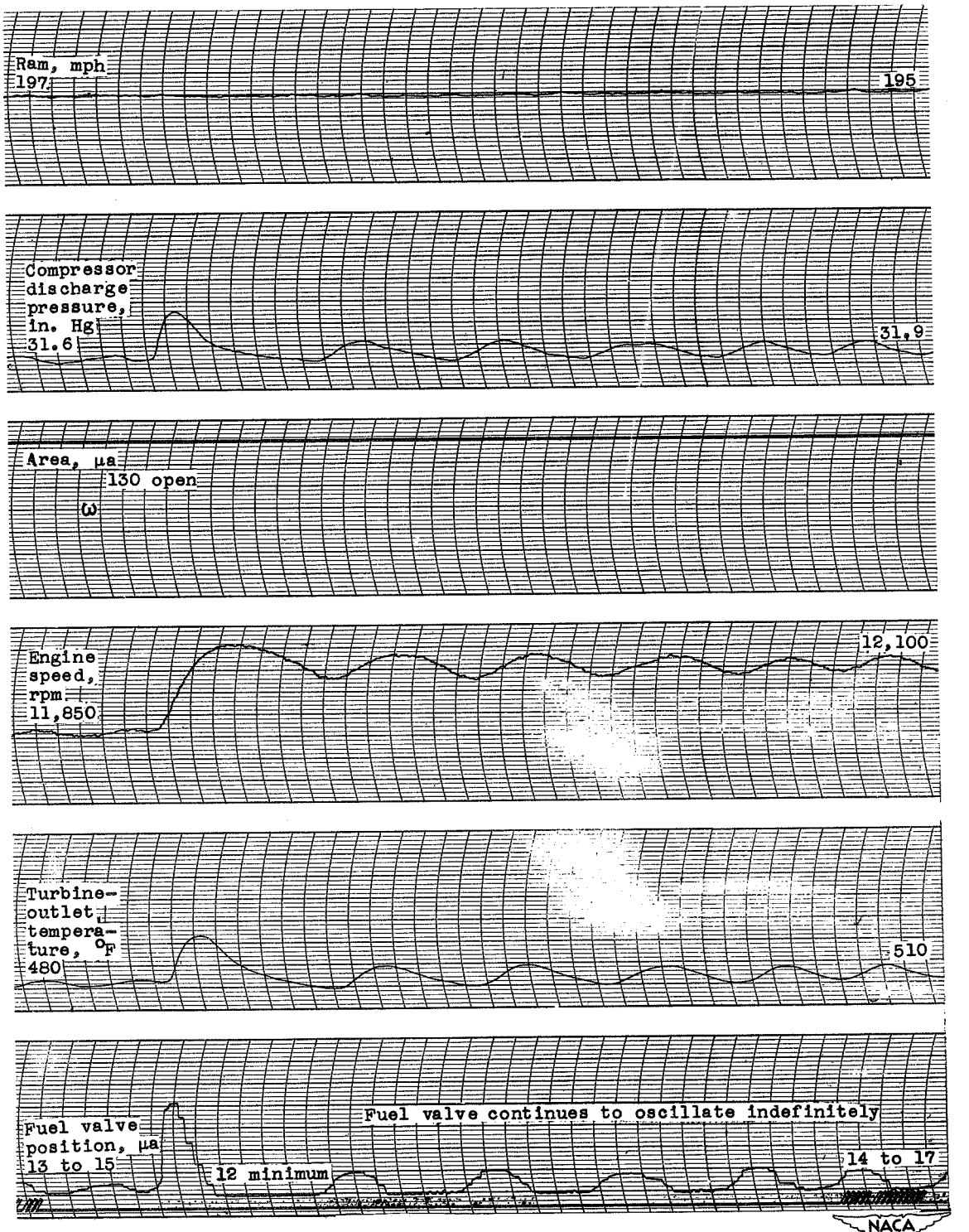
(a) Acceleration.

Figure 46. - Transient operation of automatically-controlled engine. Throttle position, 46.5° to 64.5°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



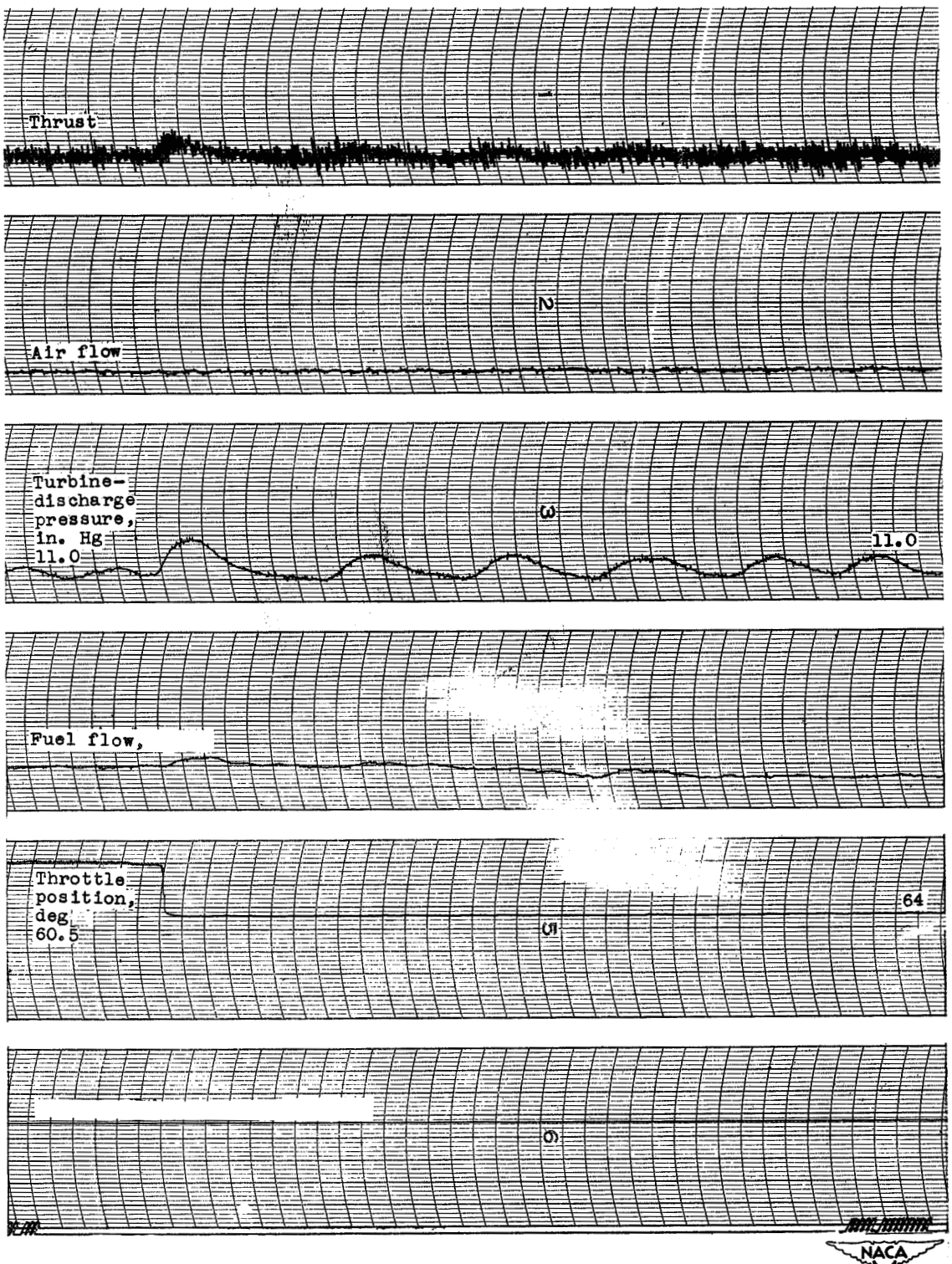
(b) Deceleration.

Figure 46. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 46.5° to 64.5°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



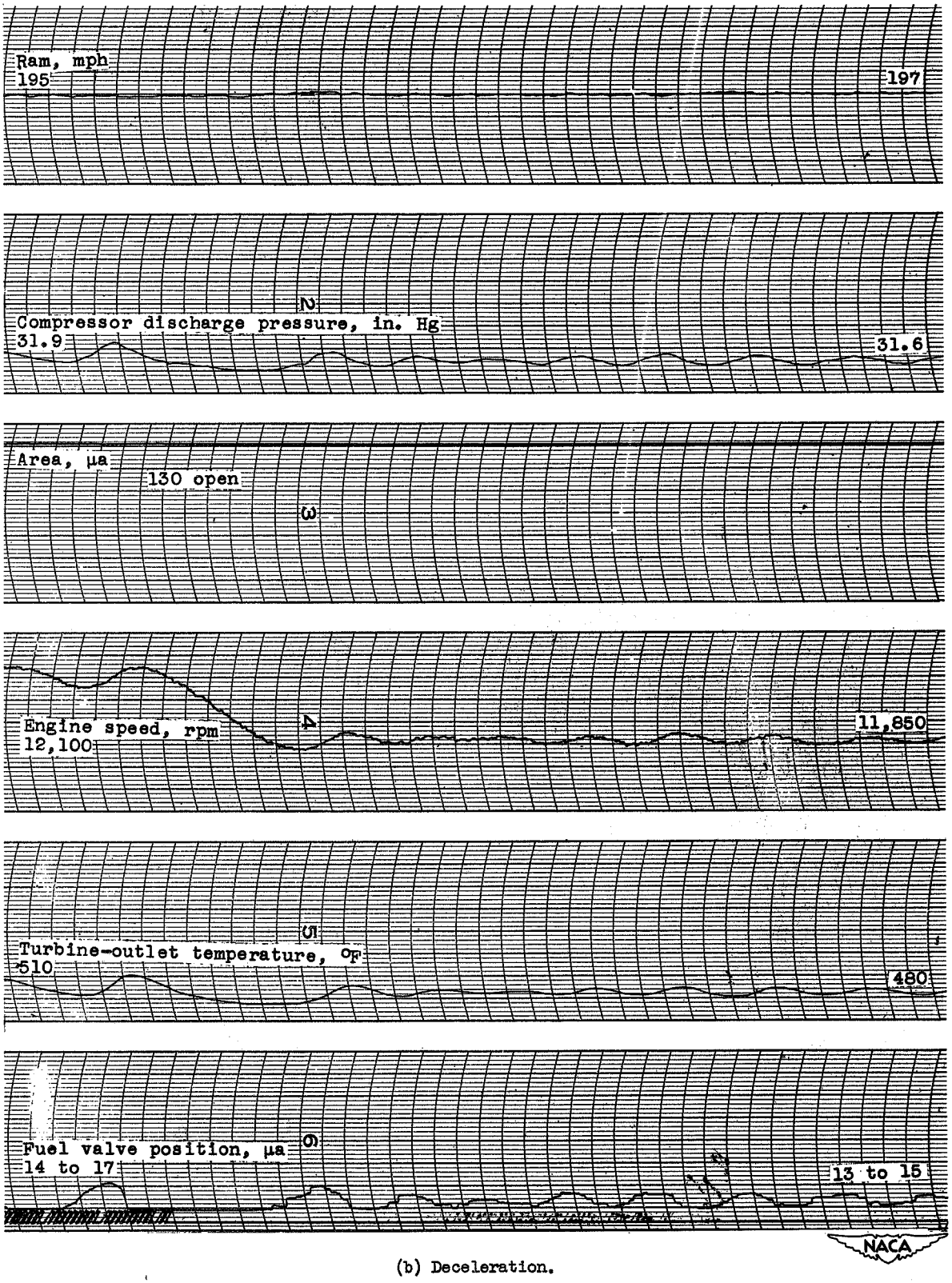
(a) Acceleration.

Figure 47. - Transient operation of automatically-operated engine. Throttle position, 60.5° to 64°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



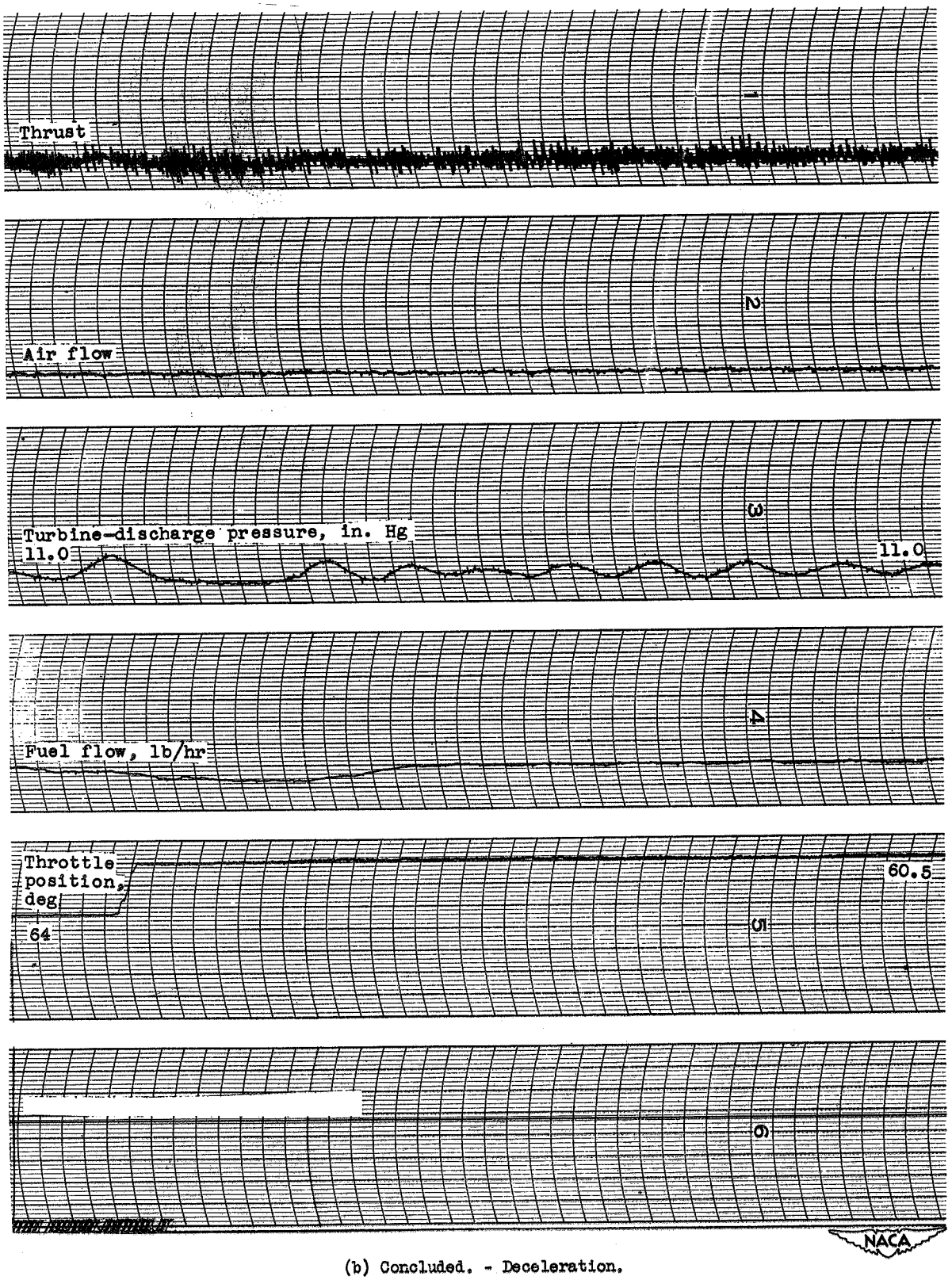
(a) Concluded. - Acceleration.

Figure 47. - Continued. Transient operation of automatically-controlled engine. Throttle position, 60.5° to 64°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 47. - Continued. Transient operation of automatically-controlled engine. Throttle position, 60.5° to 64°; altitude, 35,000 feet, nominal ram-pressure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 47. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 60.5° to 64°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.

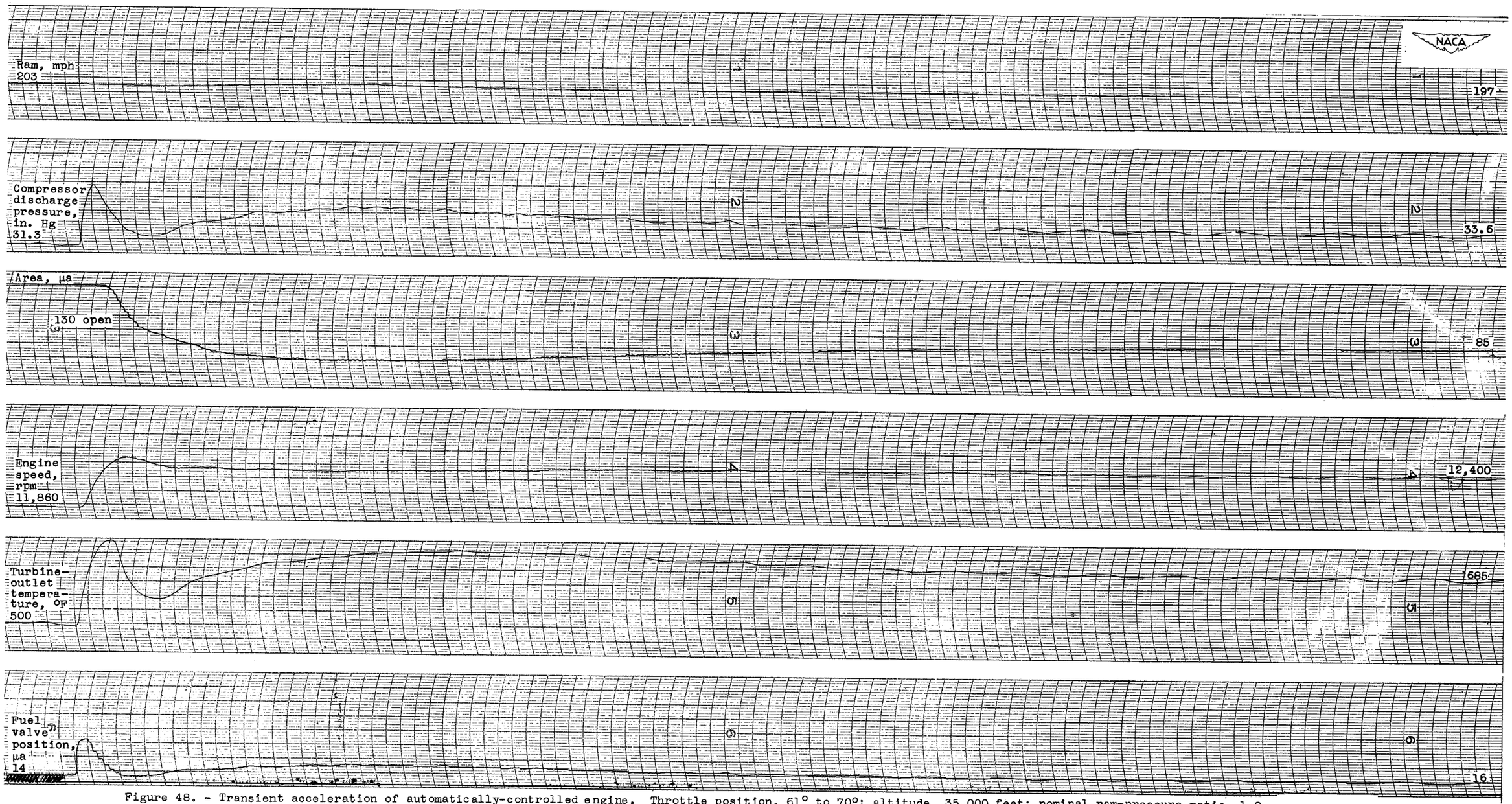
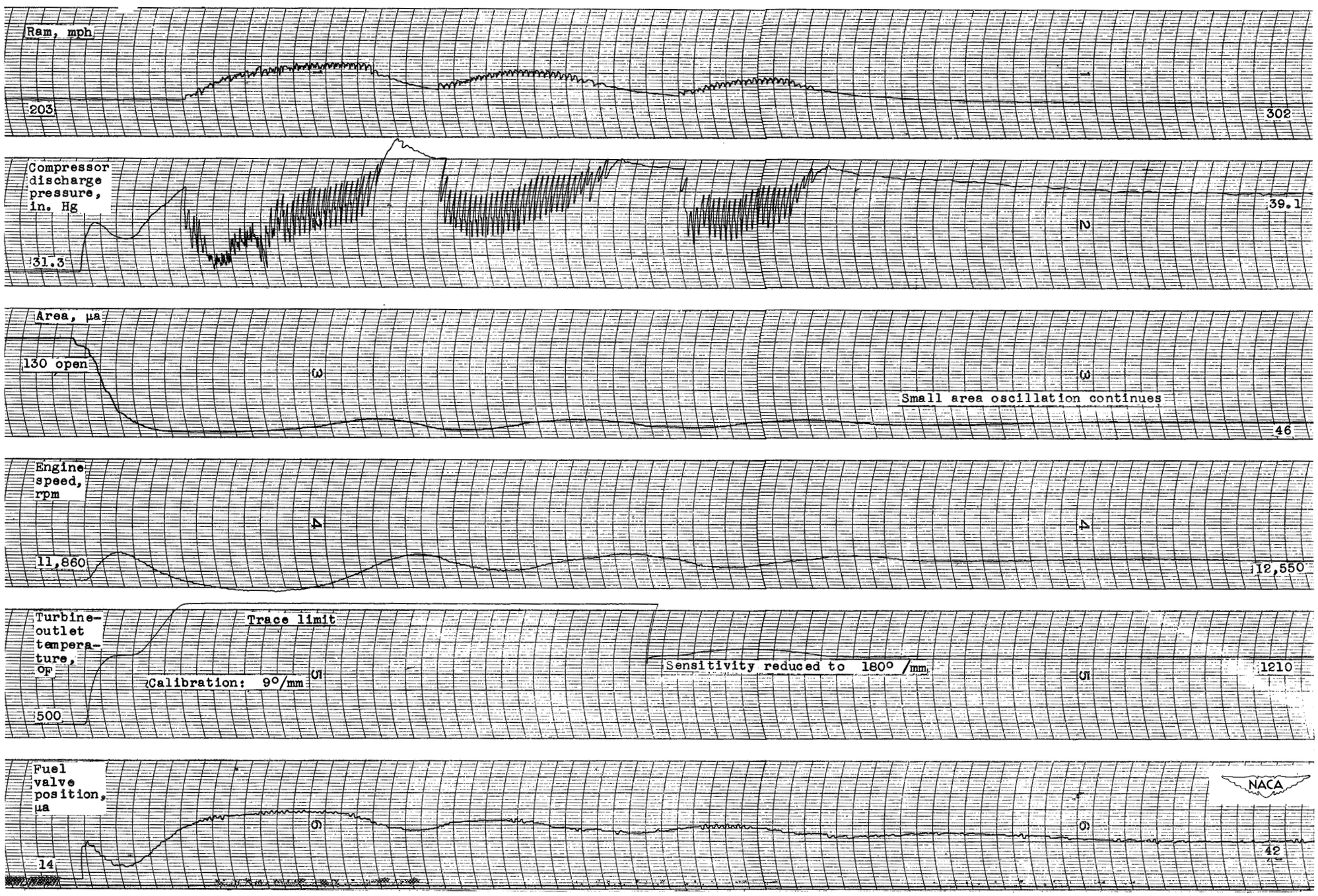
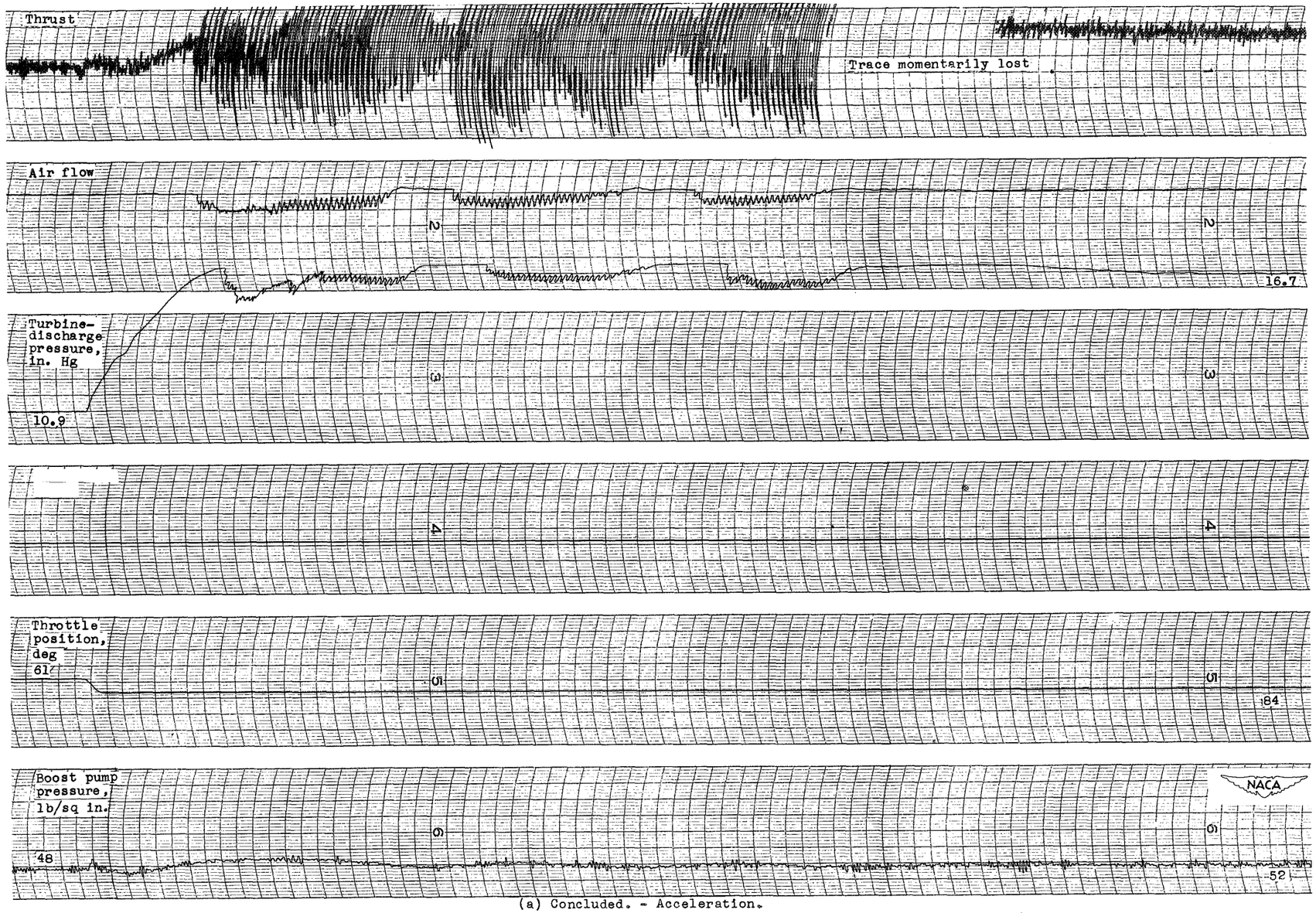


Figure 48. - Transient acceleration of automatically-controlled engine. Throttle position, 61° to 70°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



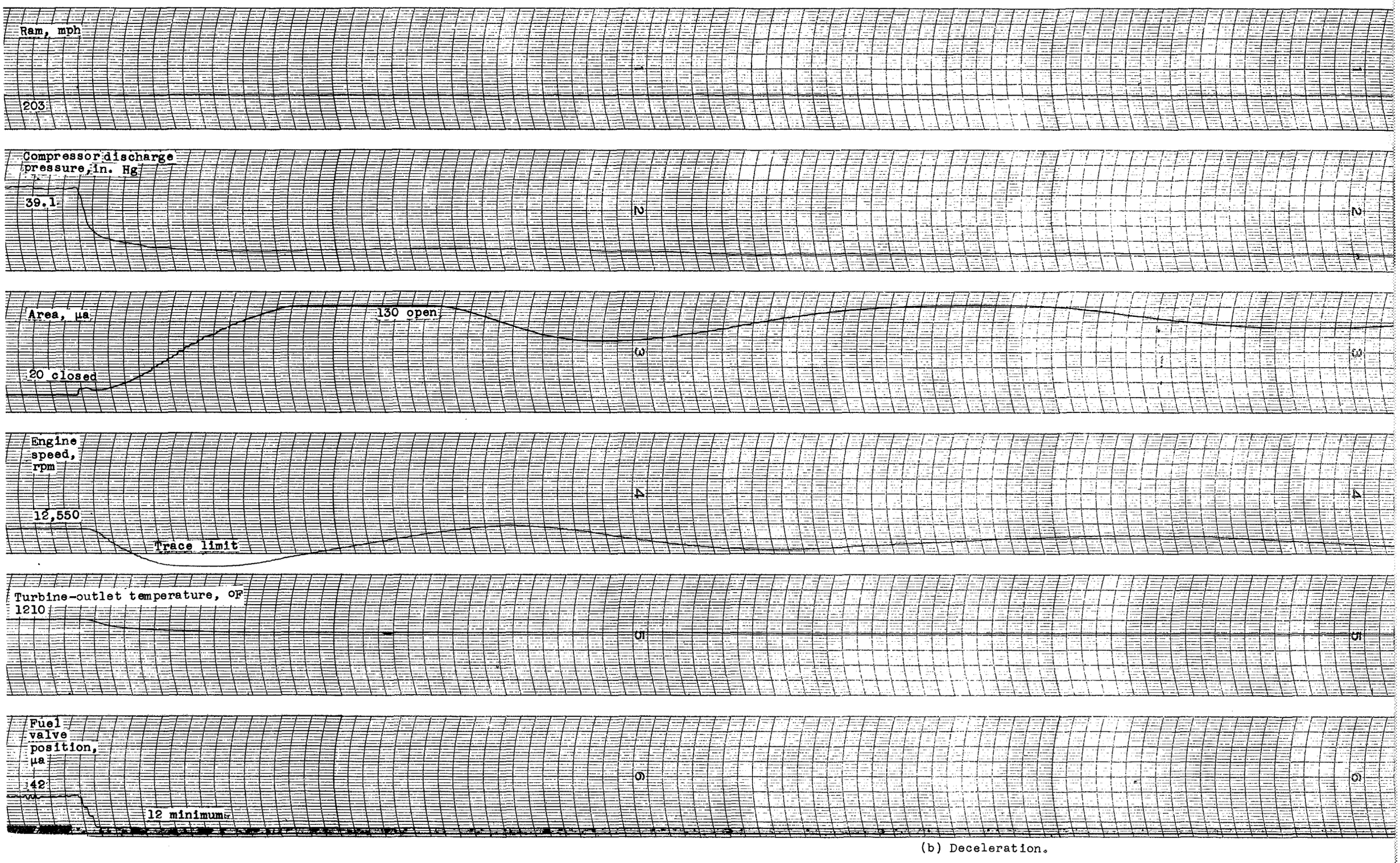
(a) Acceleration.

Figure 49. - Transient operation of automatically-controlled engine. Throttle position, 61° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



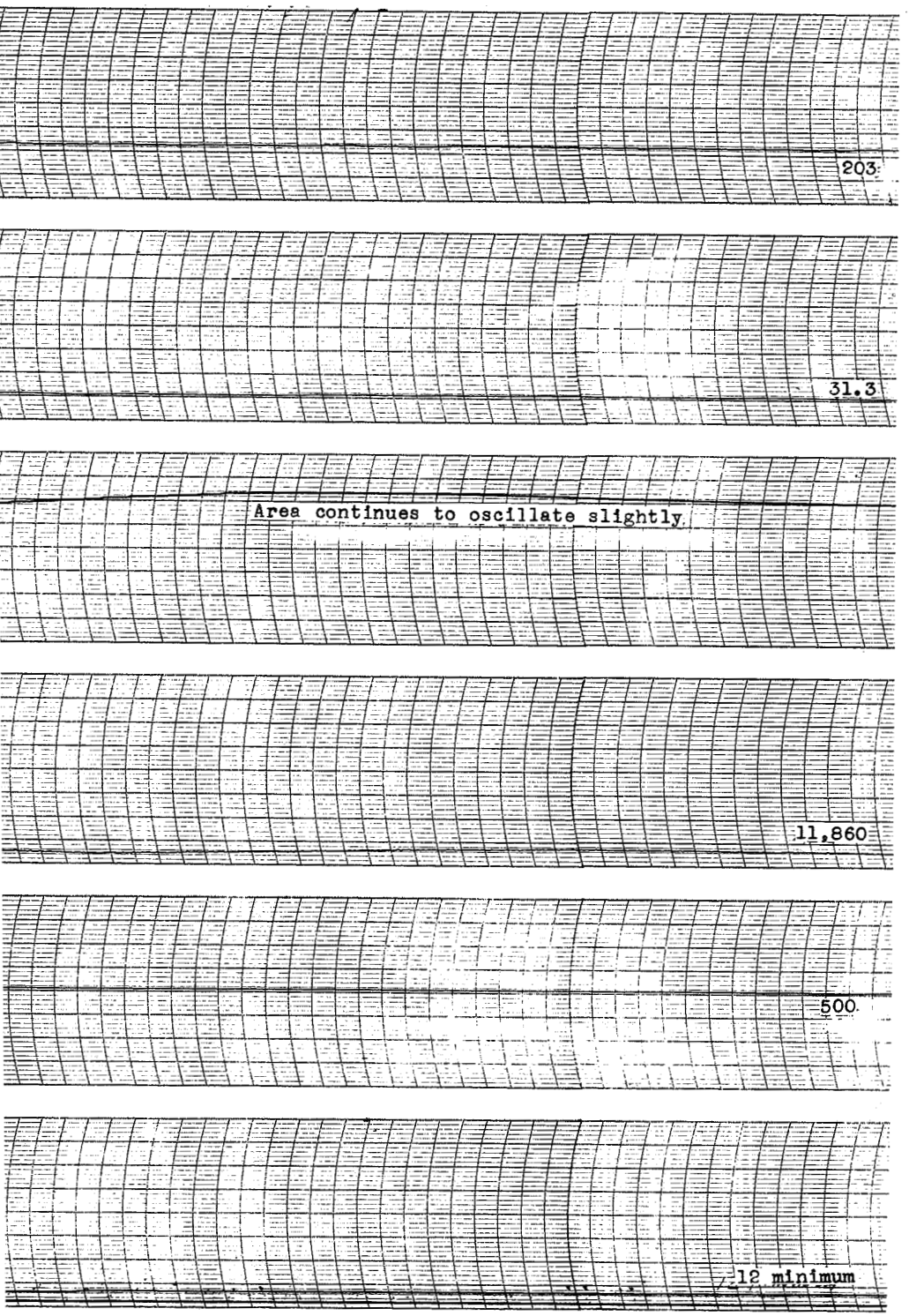
(a) Concluded. - Acceleration.

Figure 49. - Continued. Transient operation of automatically-controlled engine. Throttle position, 61° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.

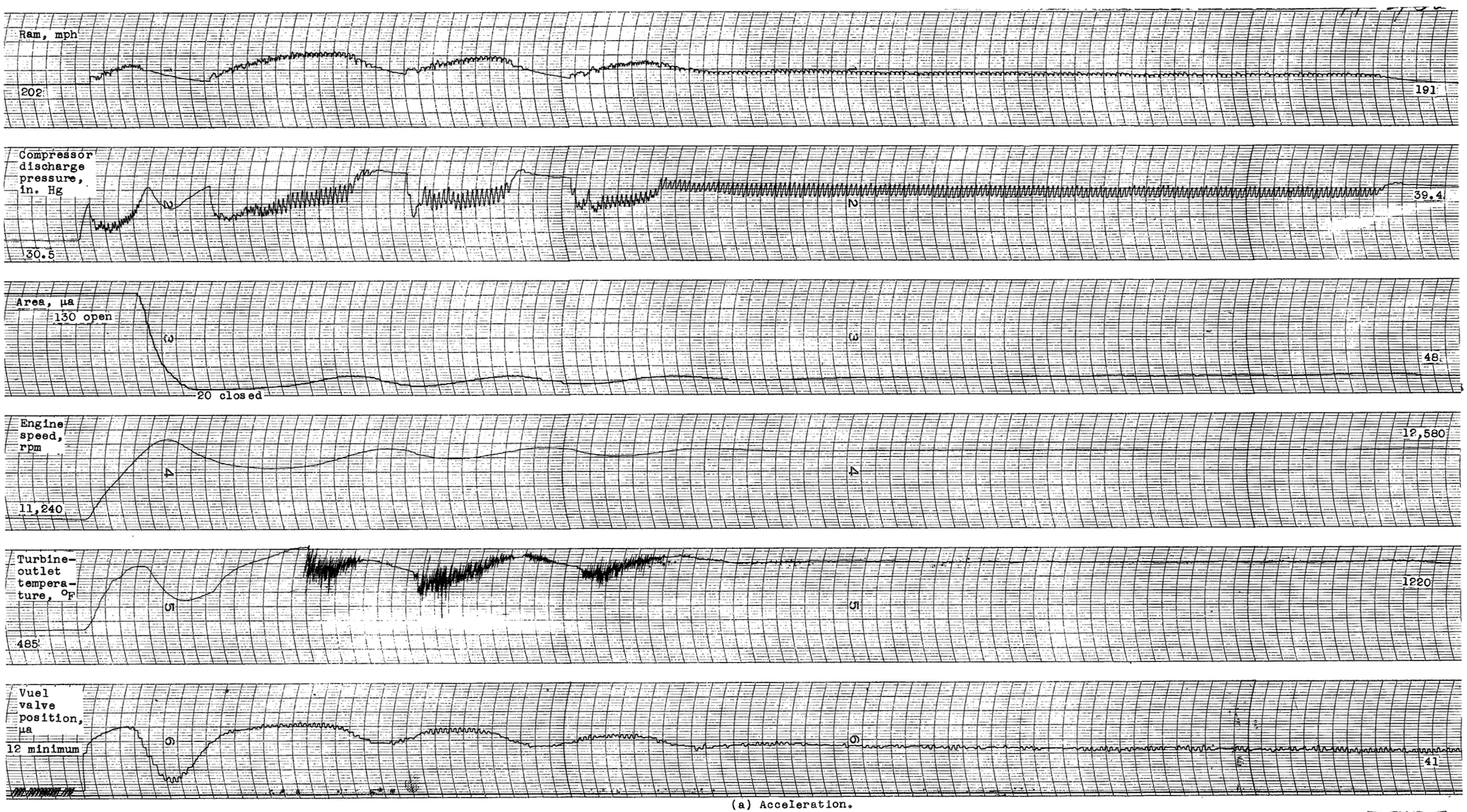


(b) Deceleration.

Figure 49.- Concluded. Transient operation of automatically-controlled engine. Throttle position, 61° to 84°; altitude, 35,000 feet; nomi

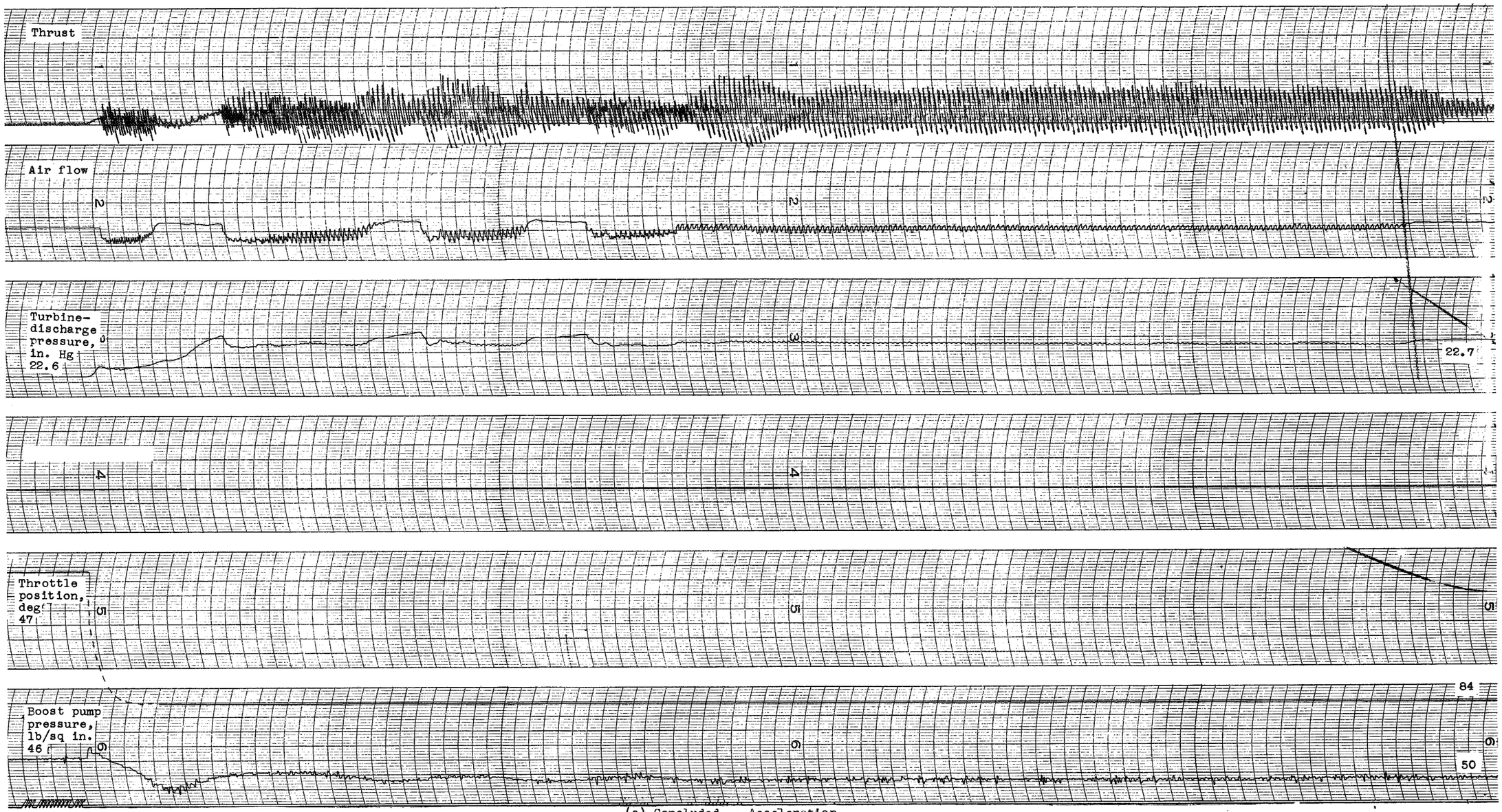


ıl ram-pressure ratio, 1.2.



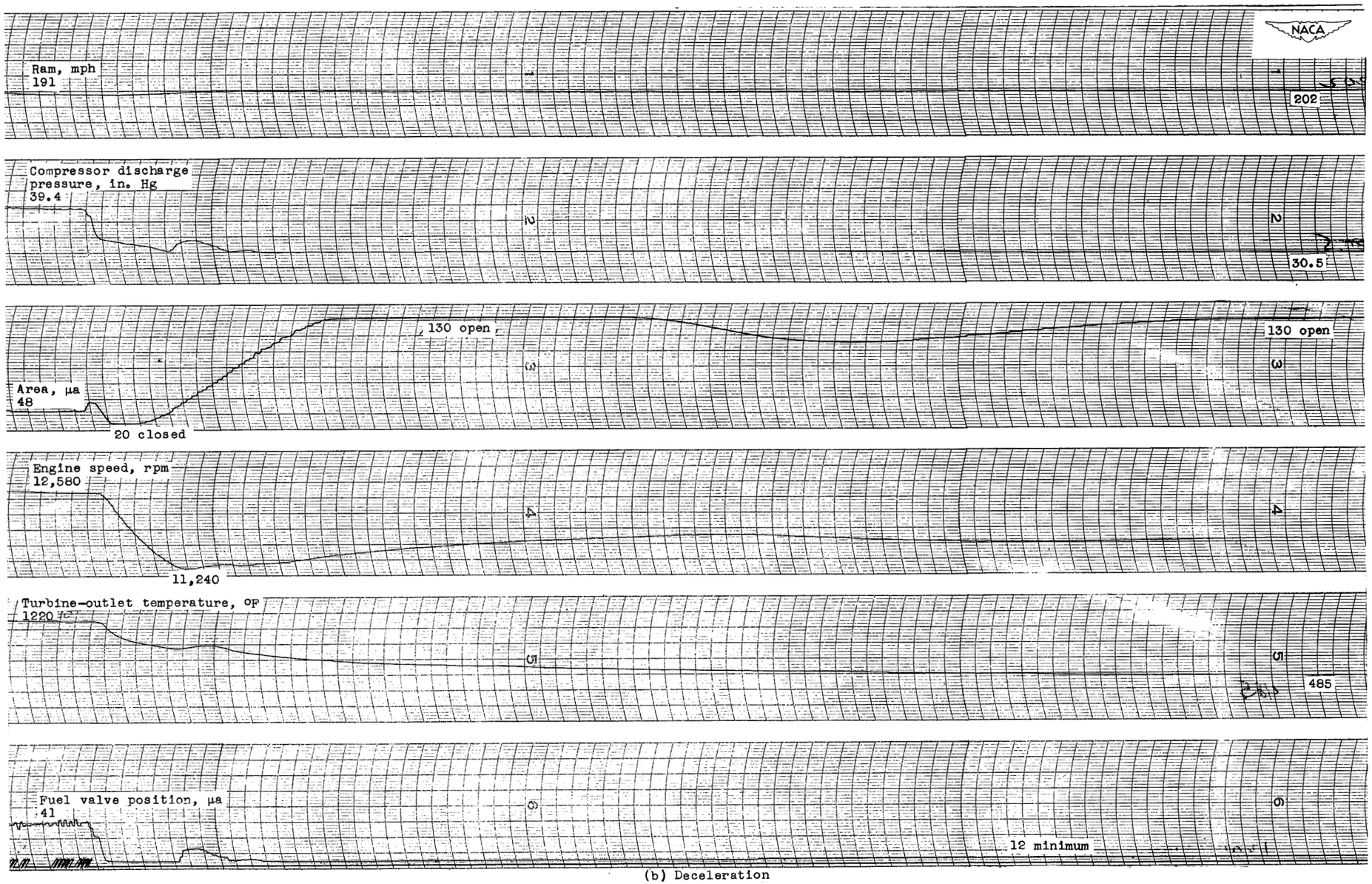
(a) Acceleration.

Figure 50. - Transient operation of automatically-controlled engine. Throttle position, 47° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



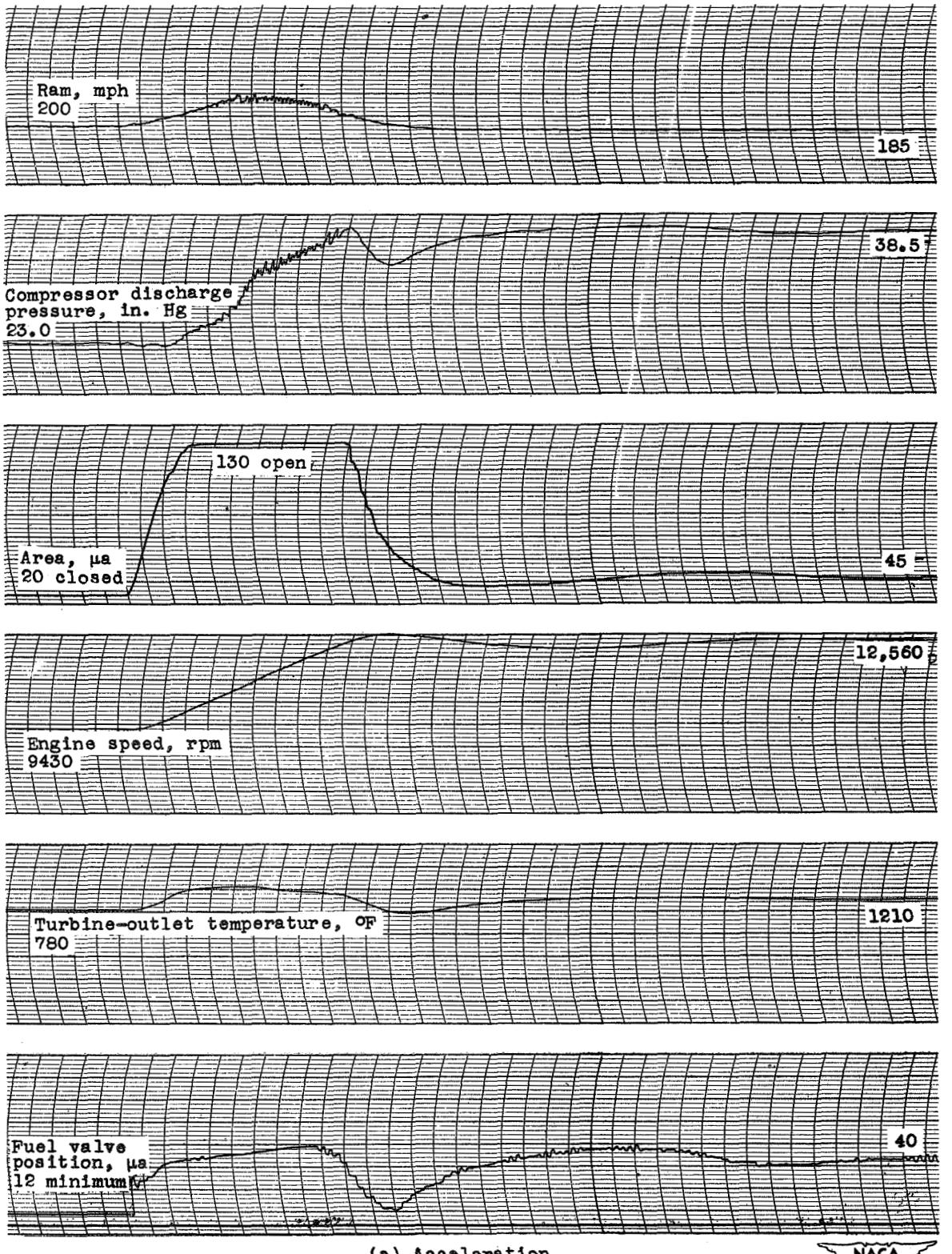
(a) Concluded. - Acceleration.

Figure 50. - Continued. Transient operation of automatically-controlled engine. Throttle position, 47° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



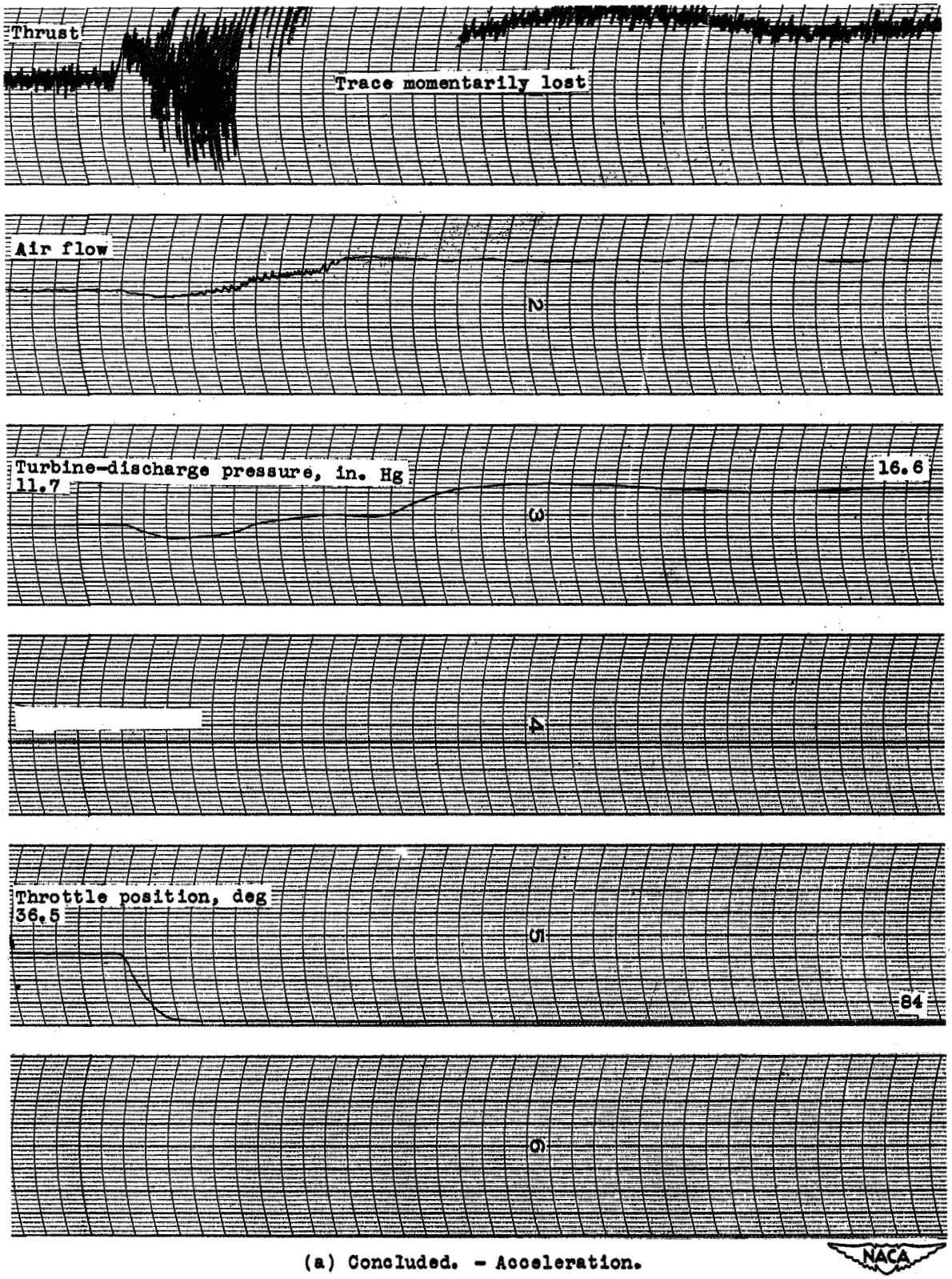
(b) Deceleration

Figure 50. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 47° to 84°; altitude, 35,000 feet: nominal ram-pressure ratio, 1.2.



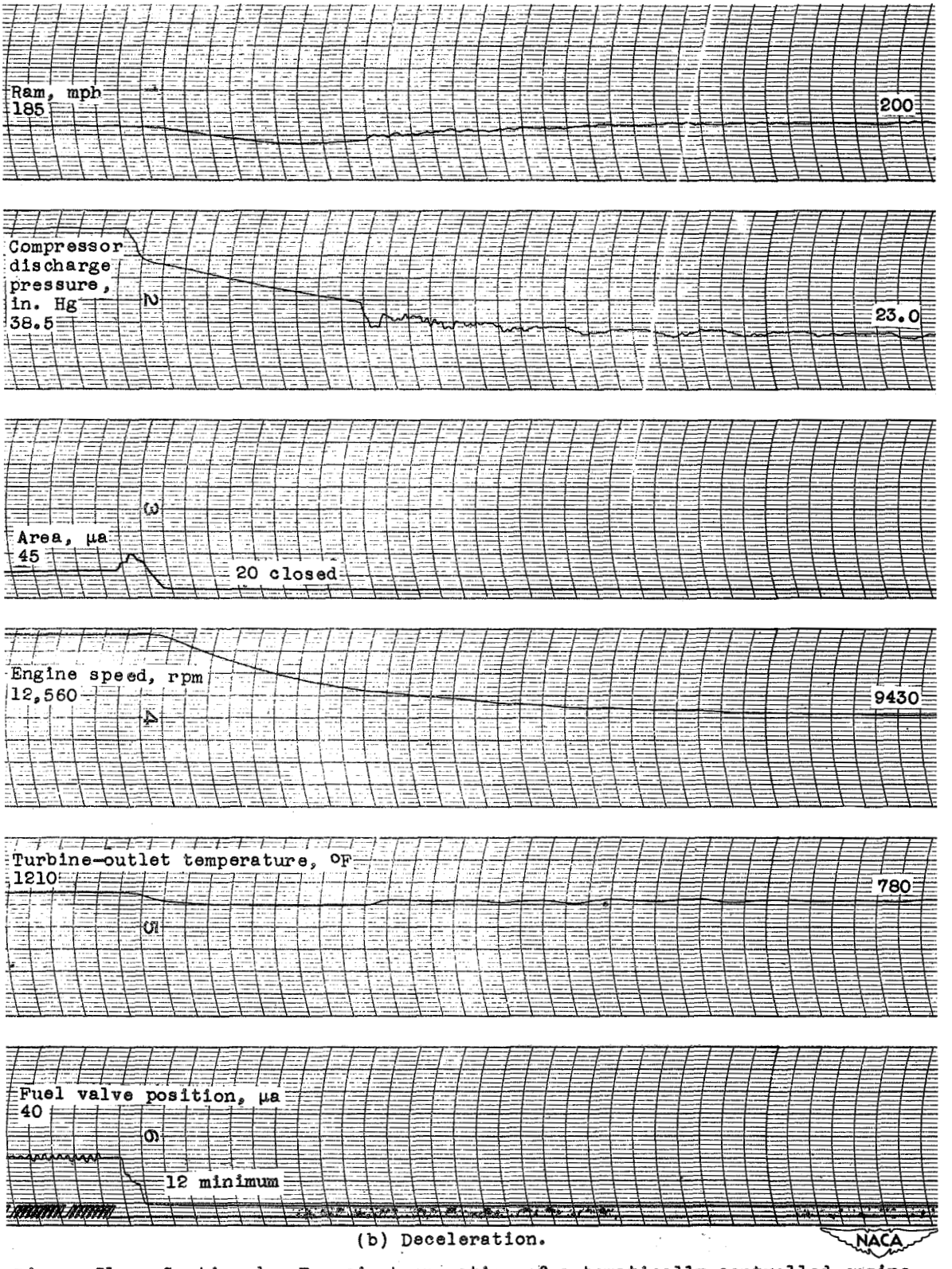
(a) Acceleration.

Figure 51. - Transient operation of automatically-controlled engine. Throttle position, 36.5° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 12.



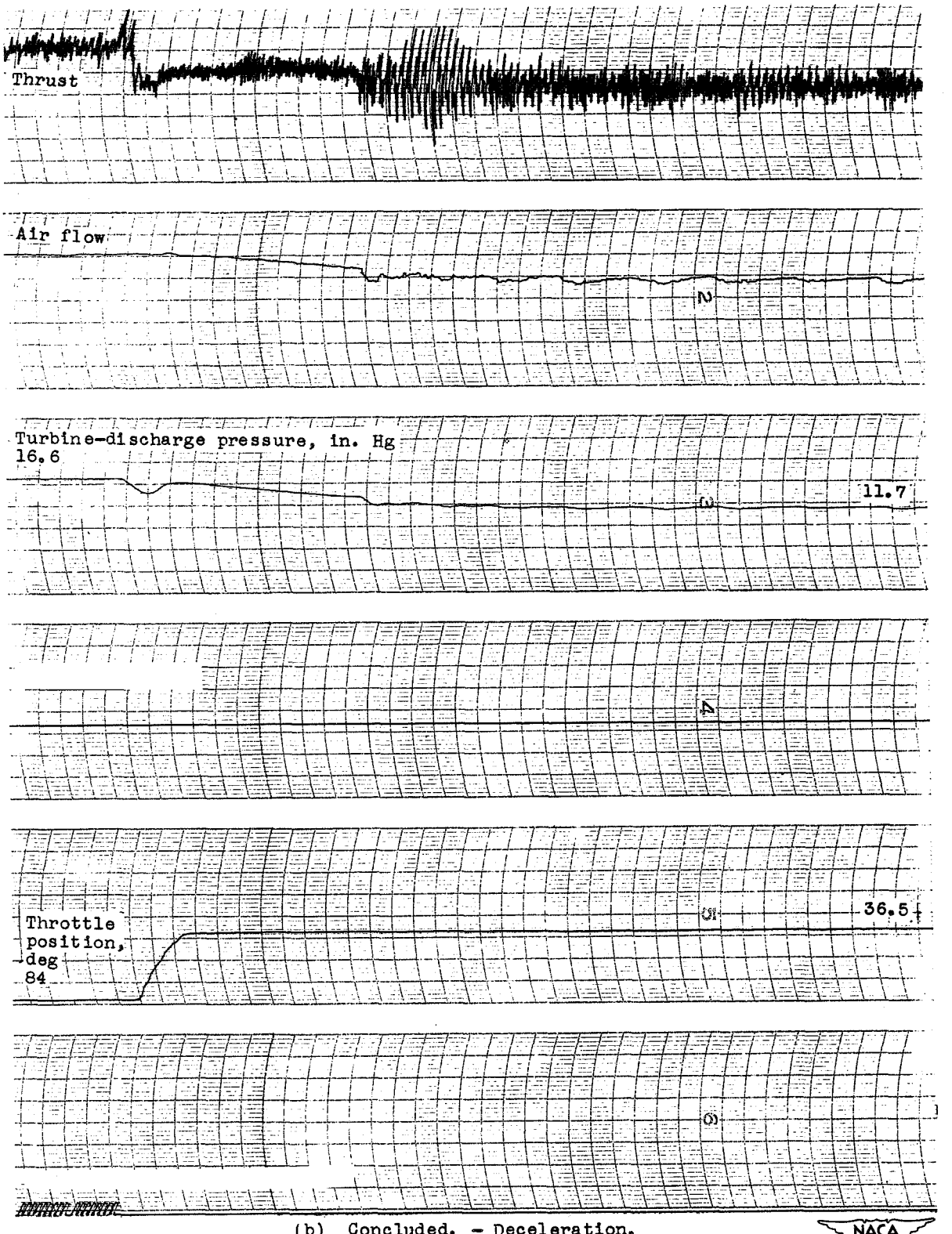
(a) Concluded. - Acceleration.

Figure 51. - Continued. Transient operation of automatically-controlled engine. Throttle position, 36.5° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 51. - Continued. Transient operation of automatically-controlled engine. Throttle position, 36.5° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.



(b) Concluded. - Deceleration.

Figure 51. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 36.5° to 84°:, altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.

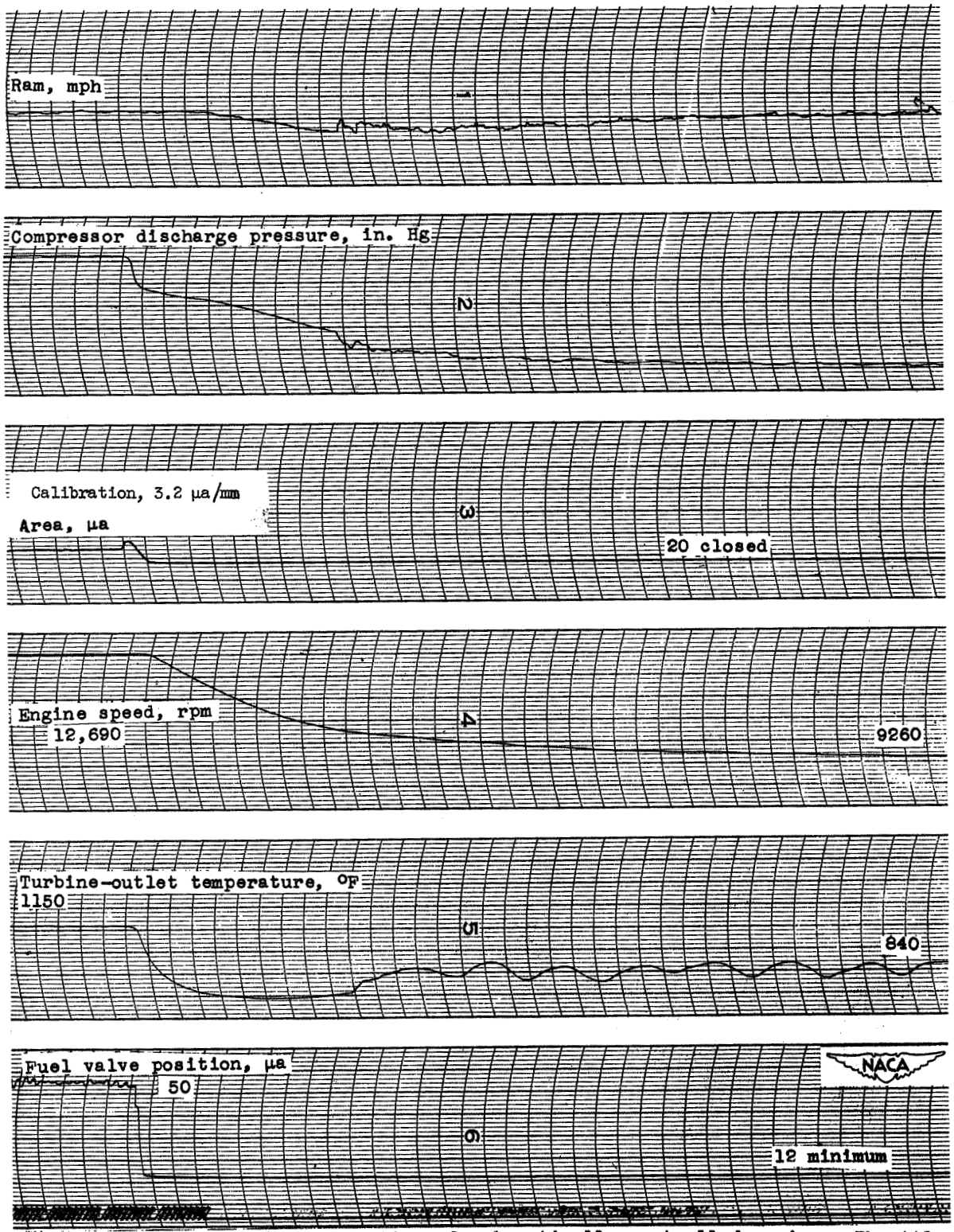


Figure 52. - Transient deceleration of automatically-controlled engine. Throttle position, 29° to 84°; altitude, 35,000 feet; nominal ram-pressure ratio, 1.2.

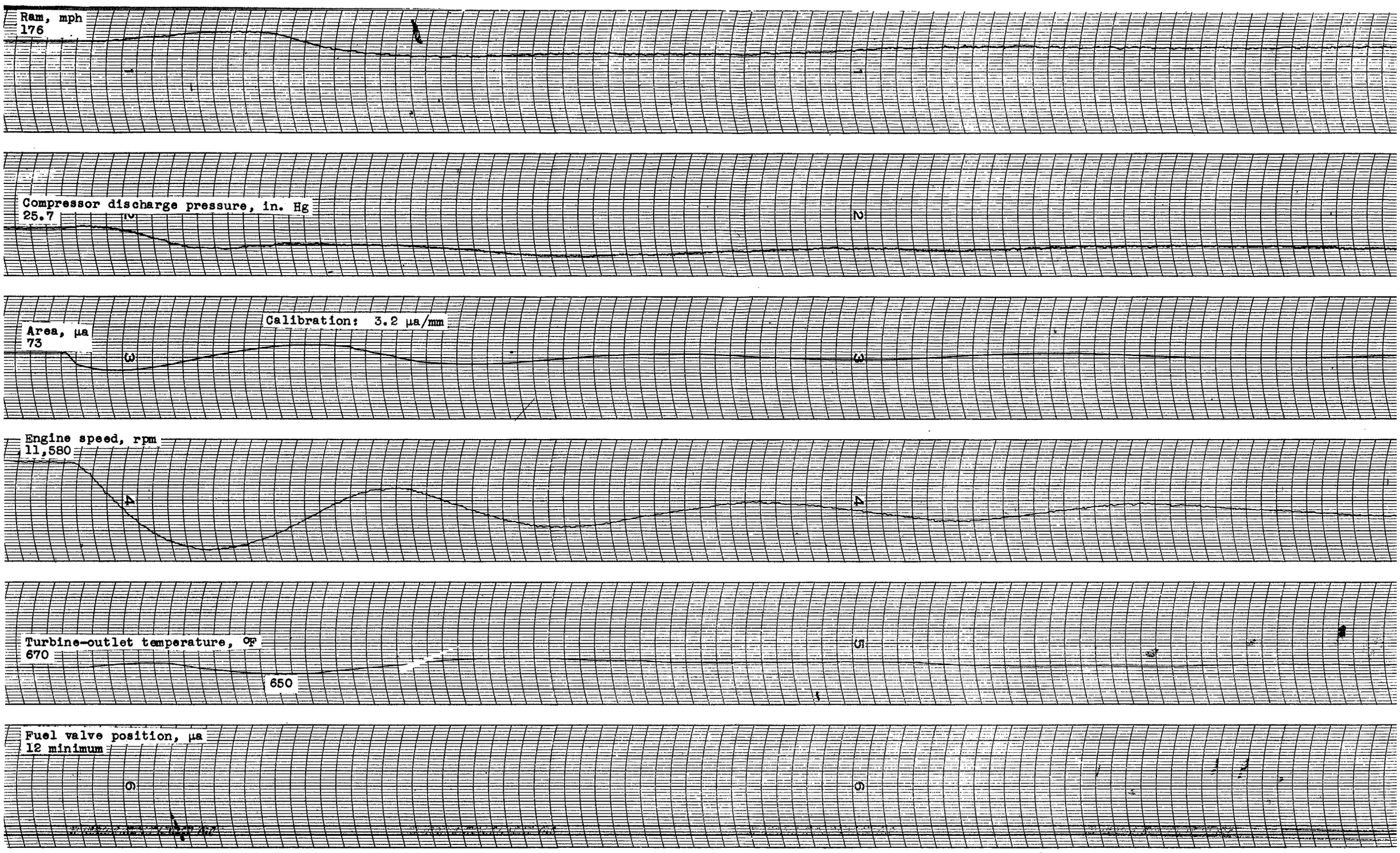
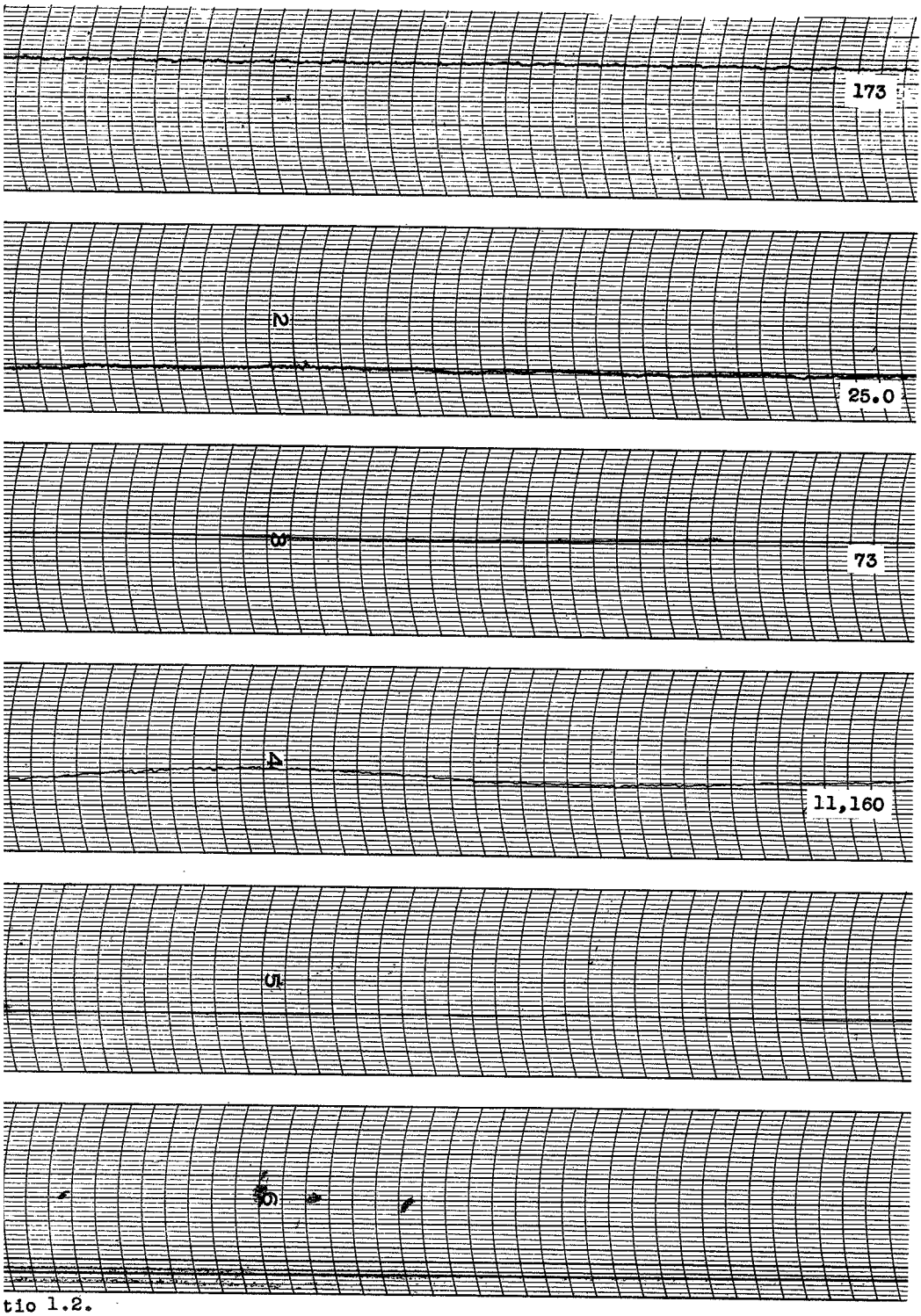


Figure 53. - Transient deceleration of automatically-controlled engine. Throttle position, 42° to 43.5°; altitude, 40,000 feet; nominal ram-pressure



tio 1.2.

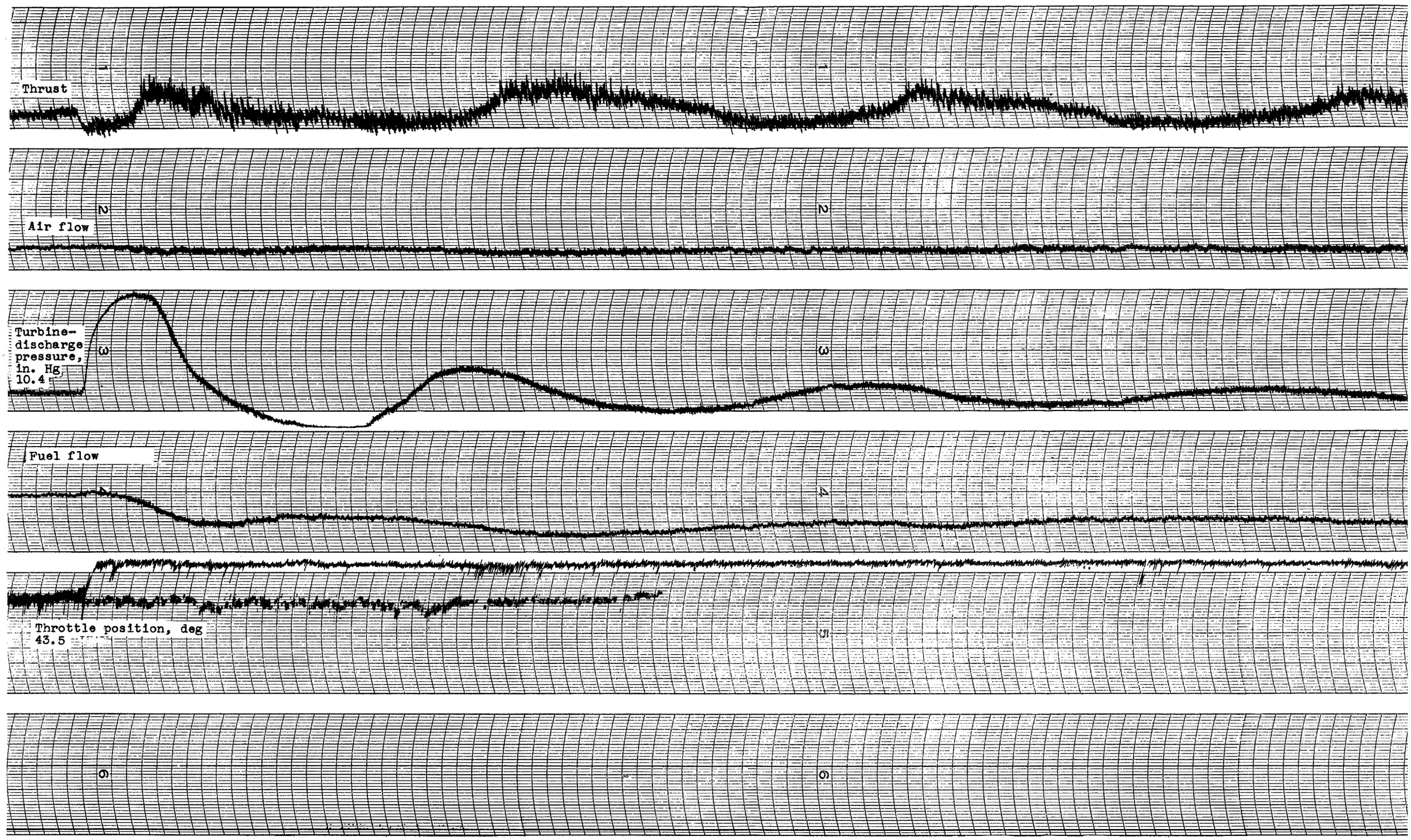
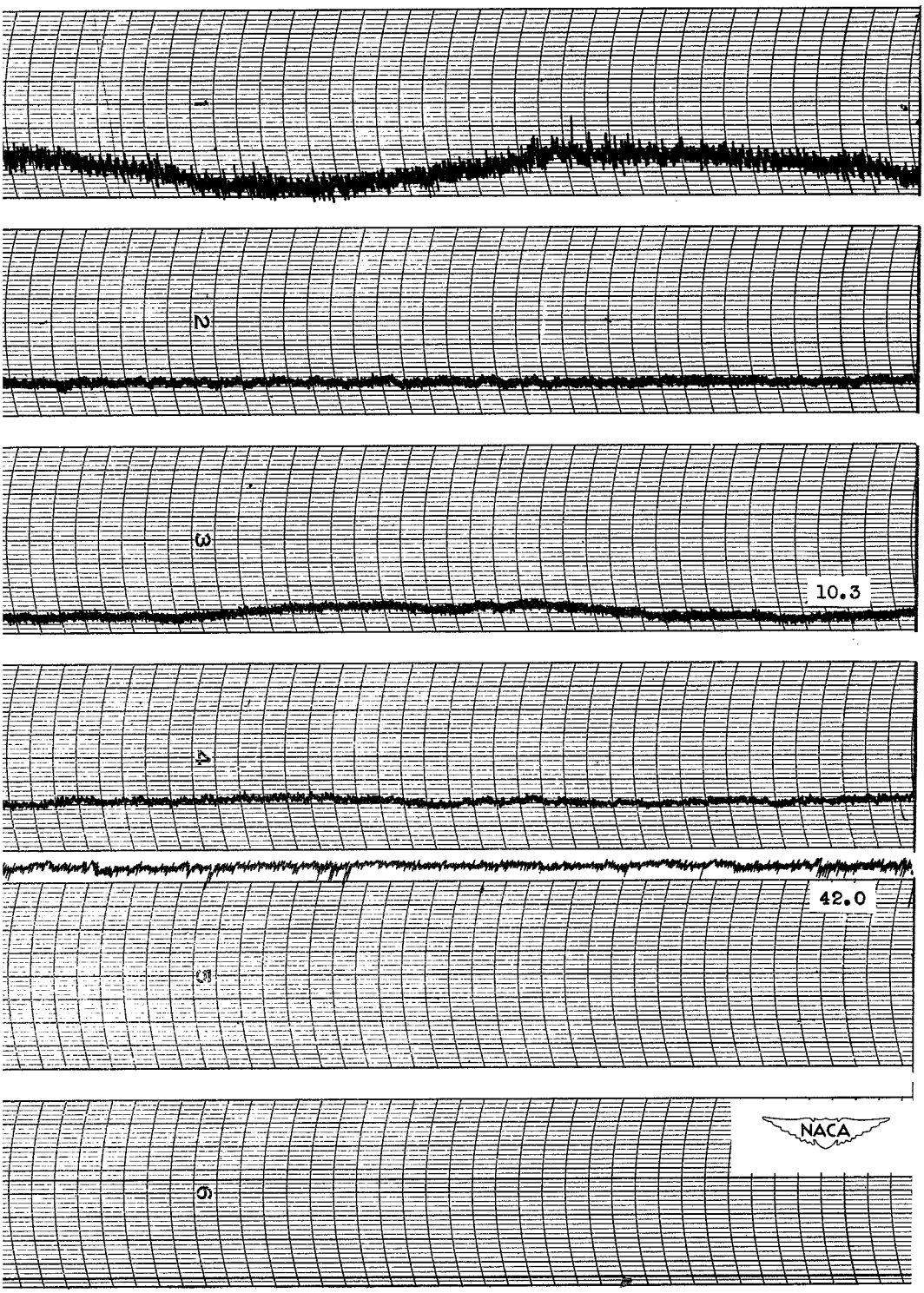
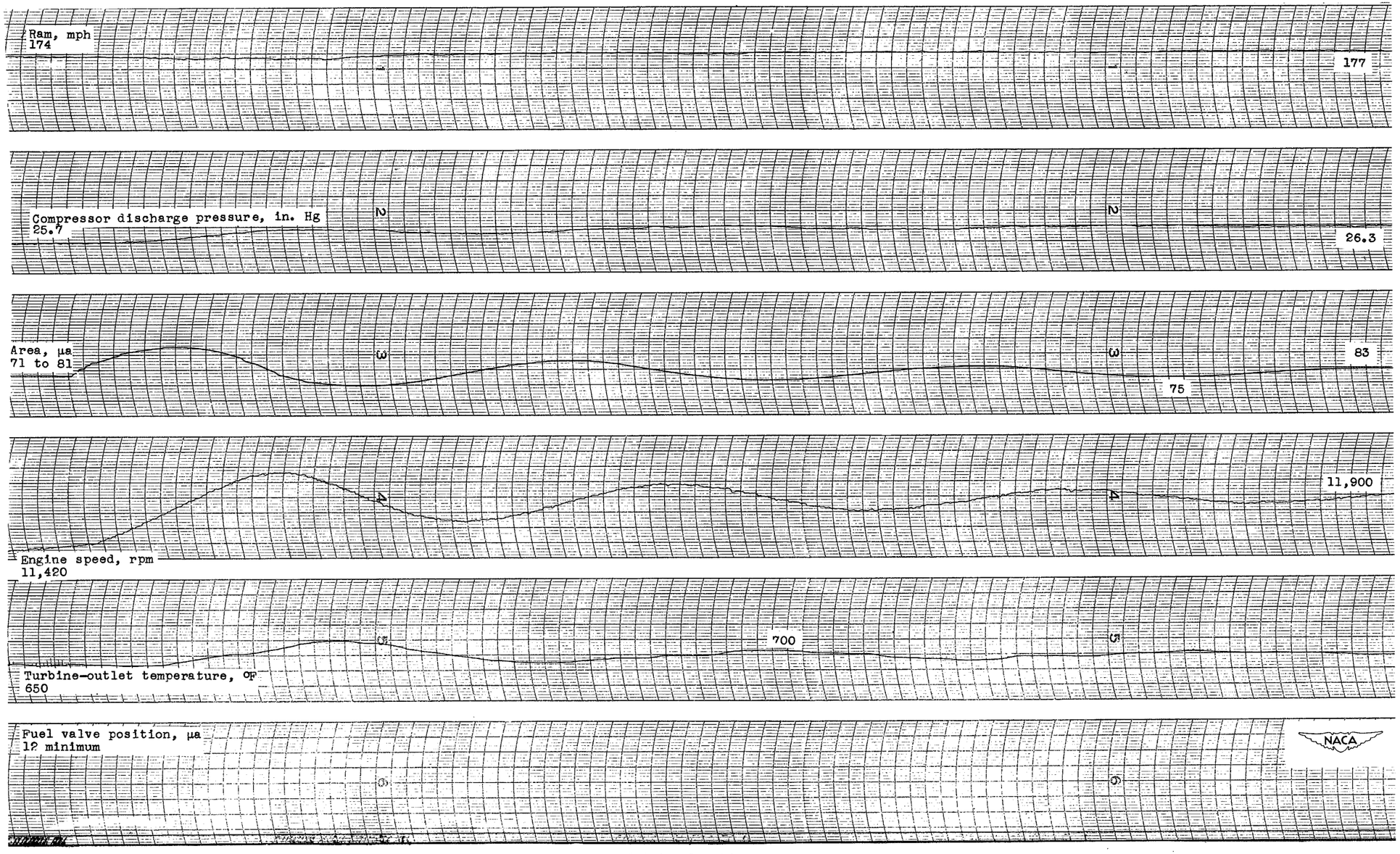


Figure 53. - Concluded. Transient deceleration of automatically-controlled engine. Throttle position, 42° to 43.5°; altitude, 40,000 feet; nominal

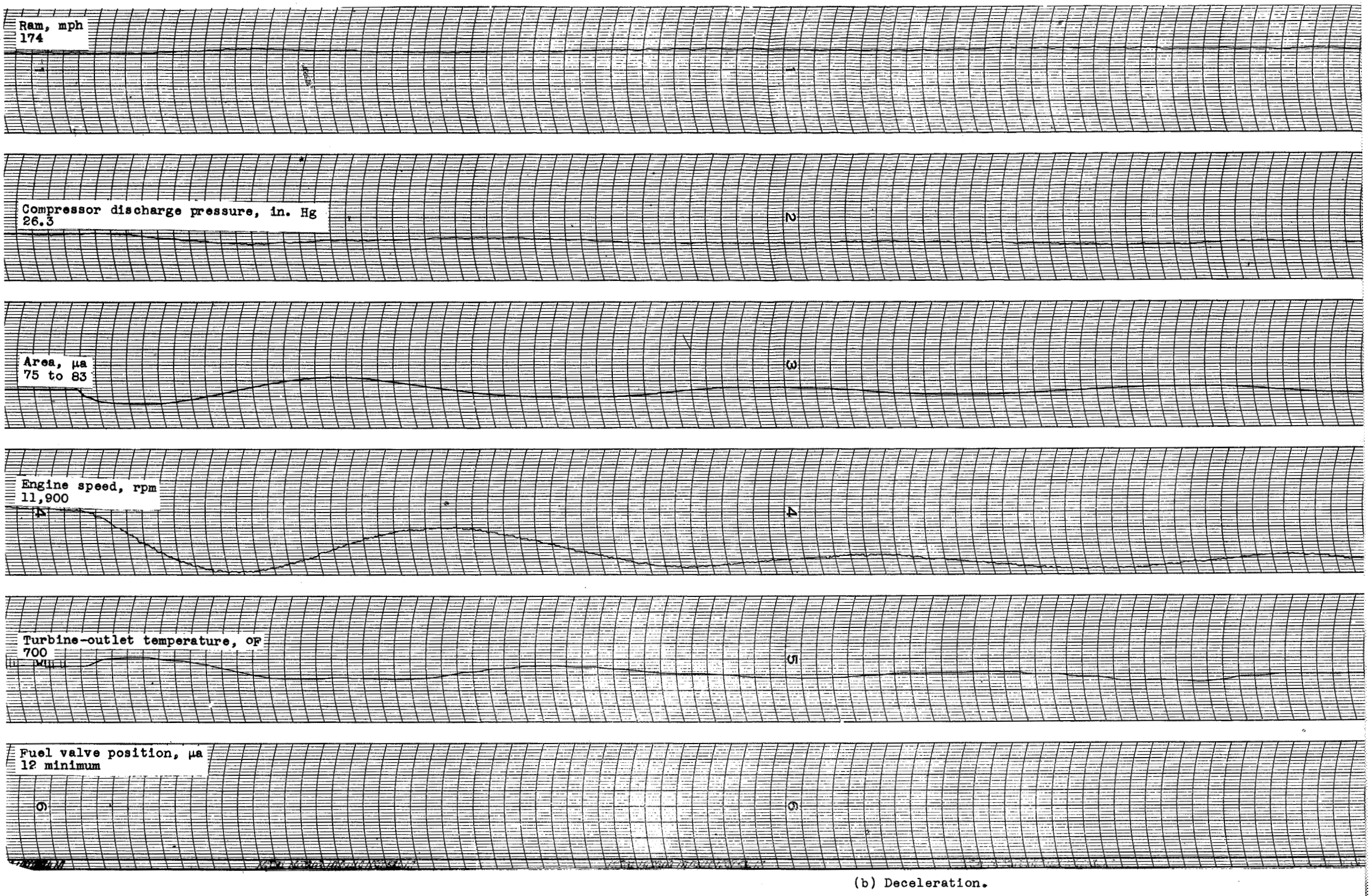


ram-pressure ratio, 1.2.



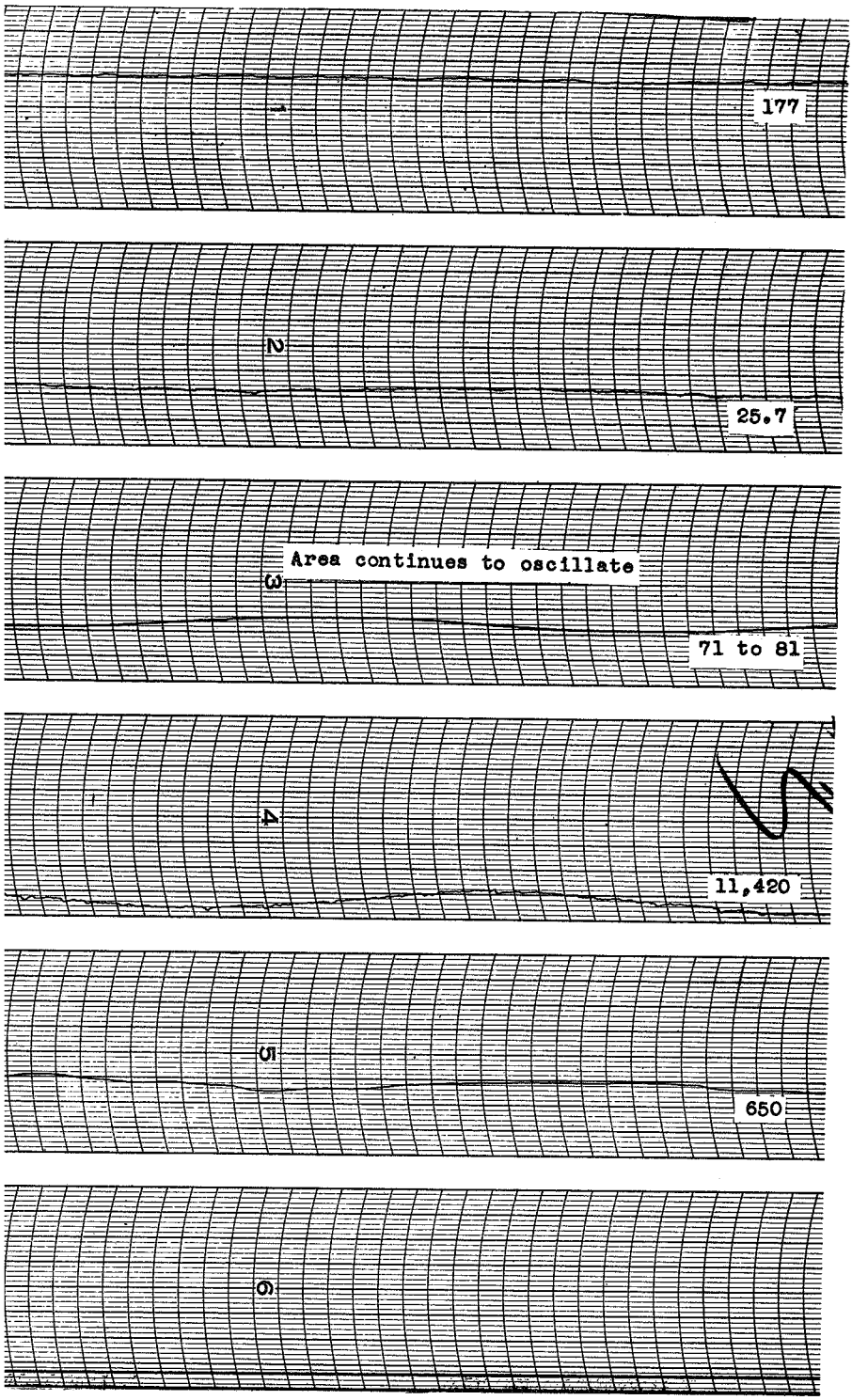
(a) Acceleration.

Figure 54. - Transient operation of automatically-controlled engine. Throttle position, 42° to 50.5°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



(b) Deceleration.

Figure 54. - Continued. Transient operation of automatically-controlled engine. Throttle position, 42° to 50.5°; altitude, 40,000 feet;



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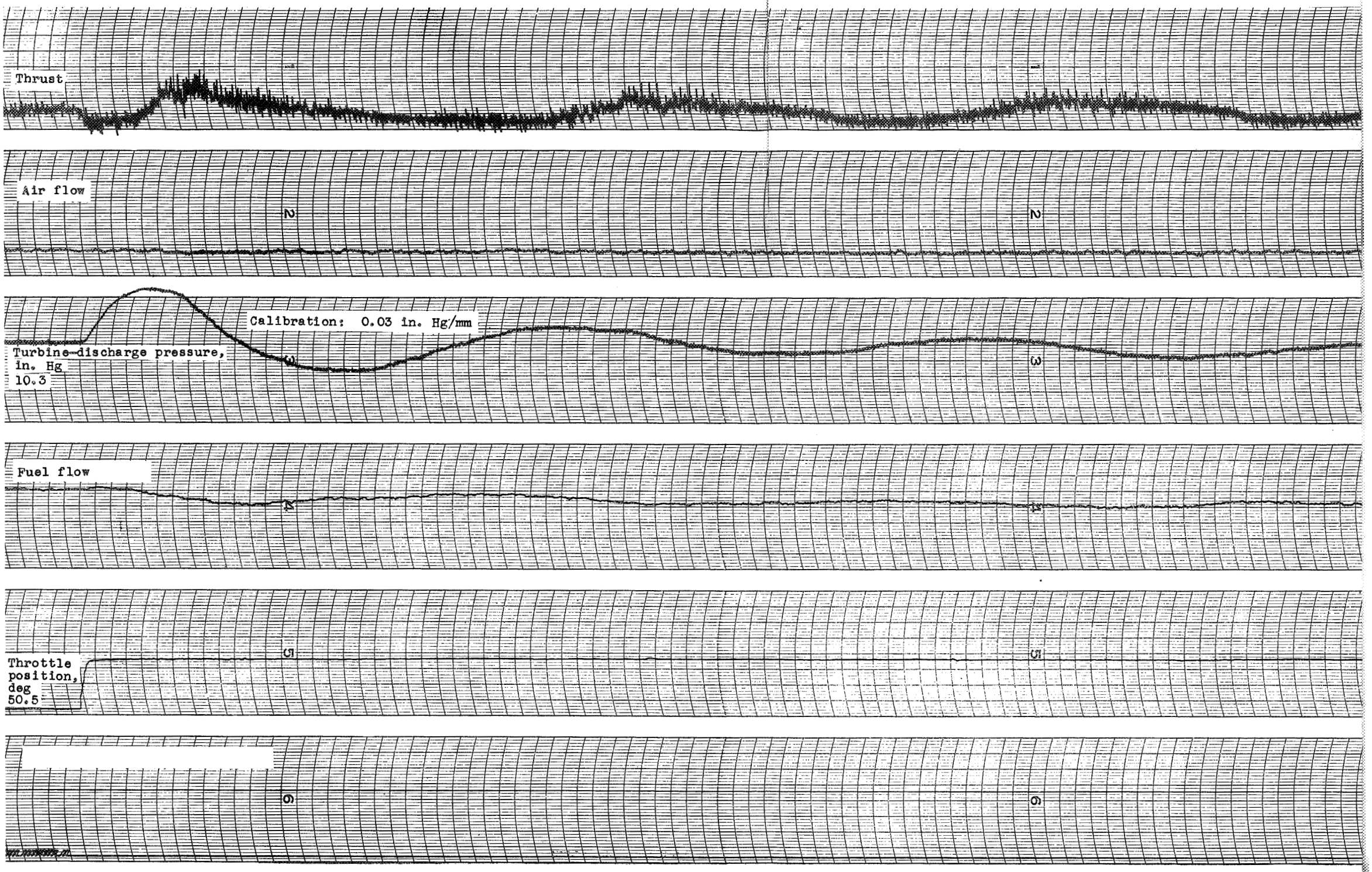
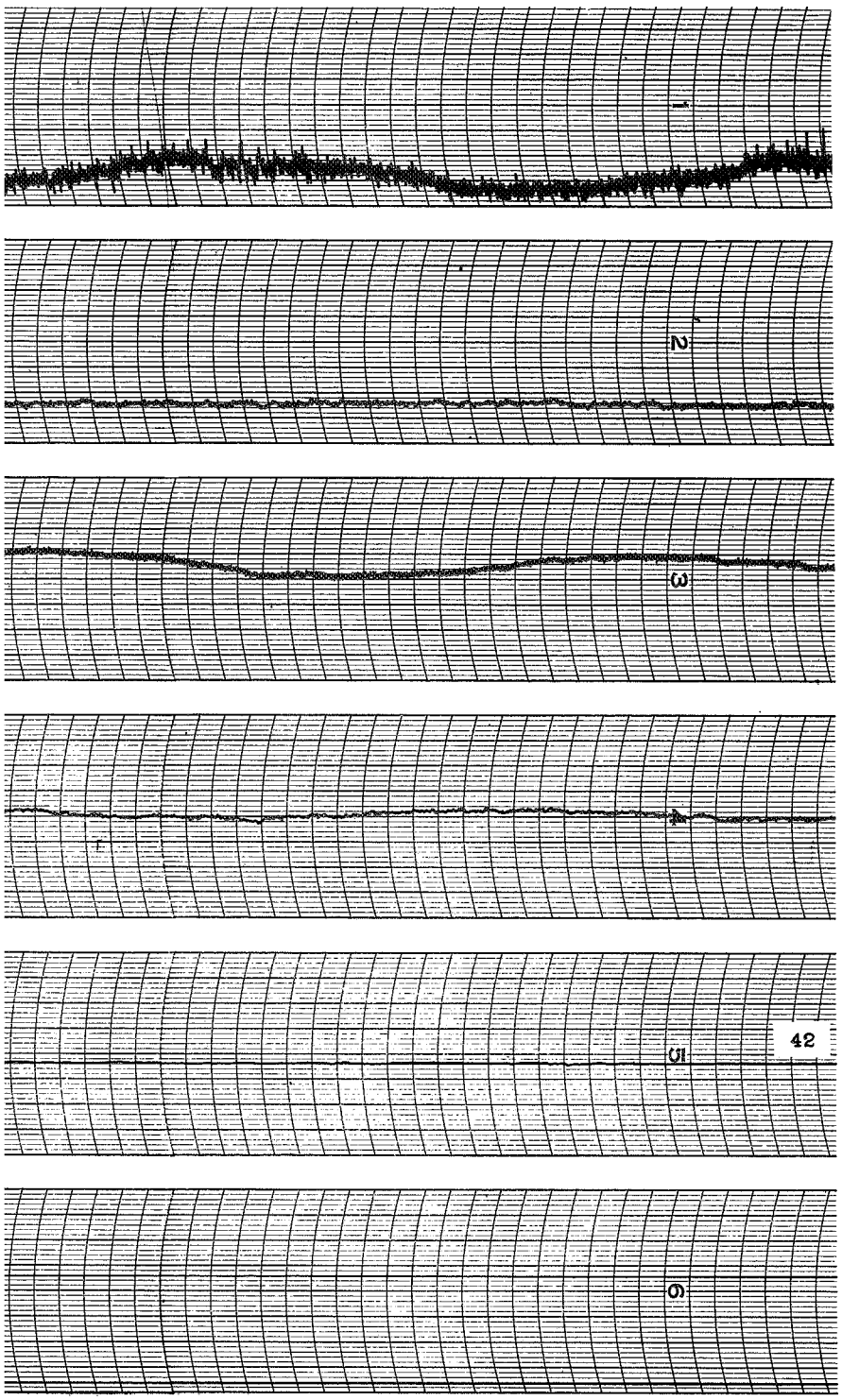
ominal ram-pressure ratio, 1.2.

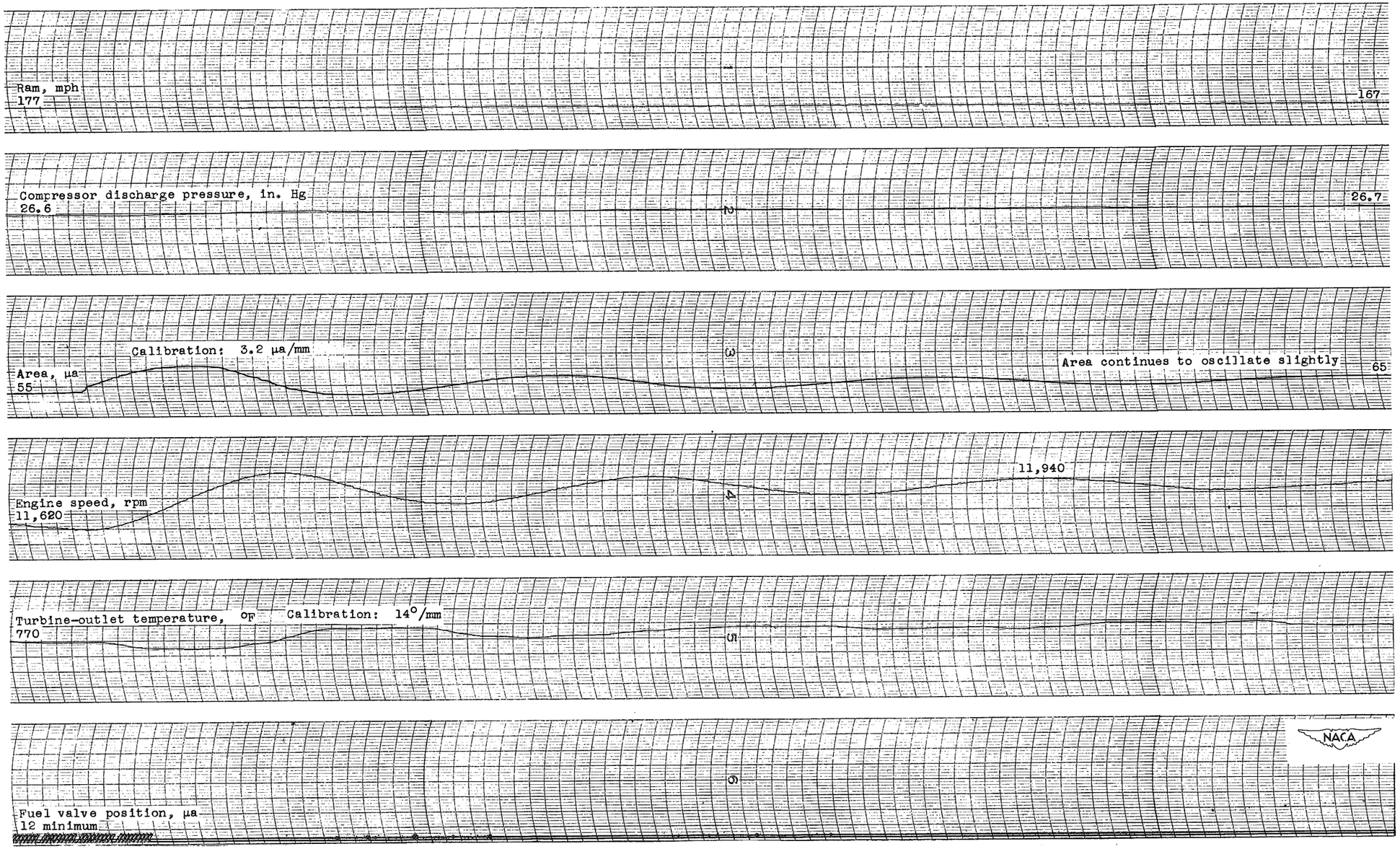


(b) Concluded. - Deceleration.

Figure 54. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 42° to 50.5°; altitude, 40,000 feet; r

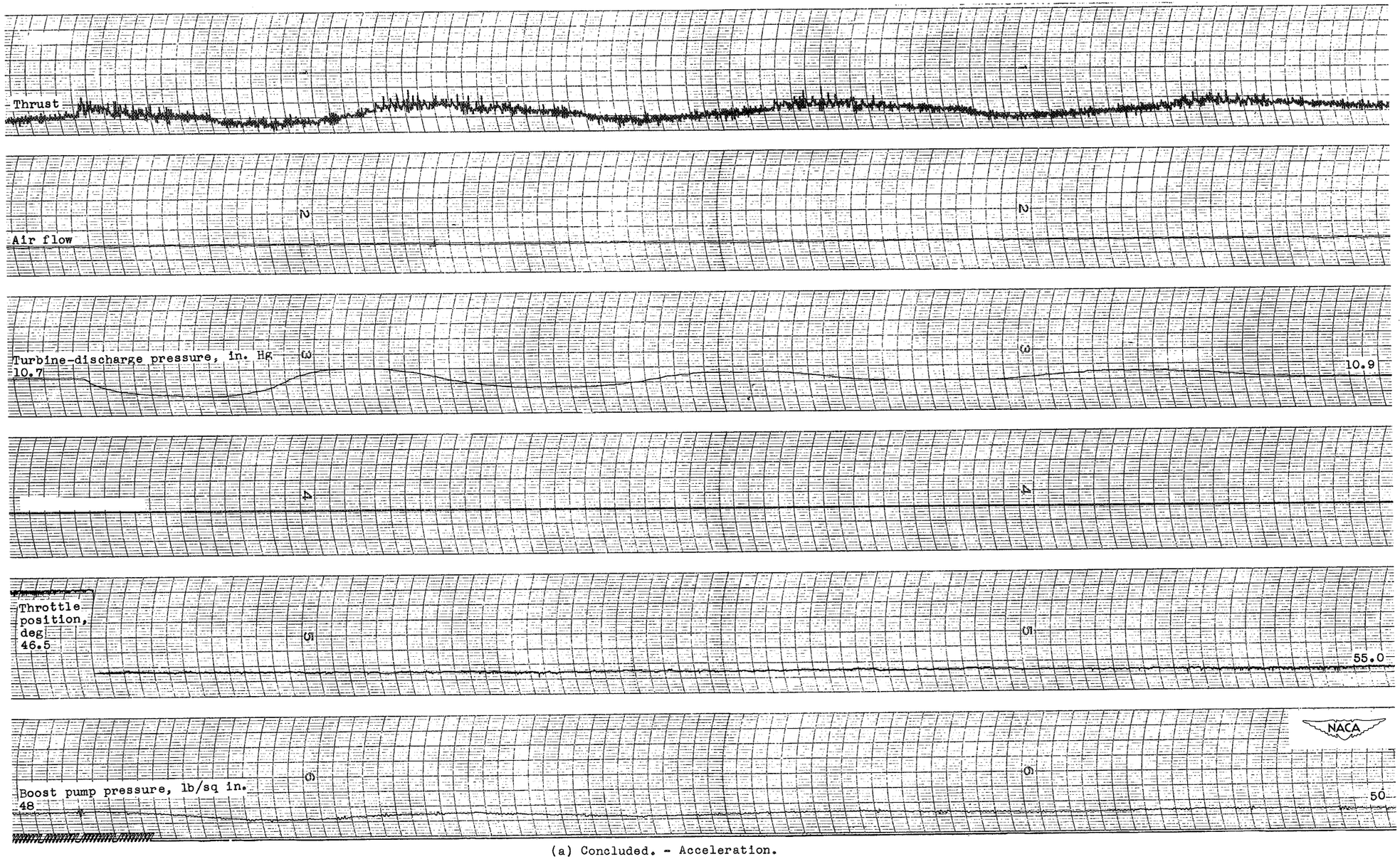


ominal ram-pressure ratio, 1.2.



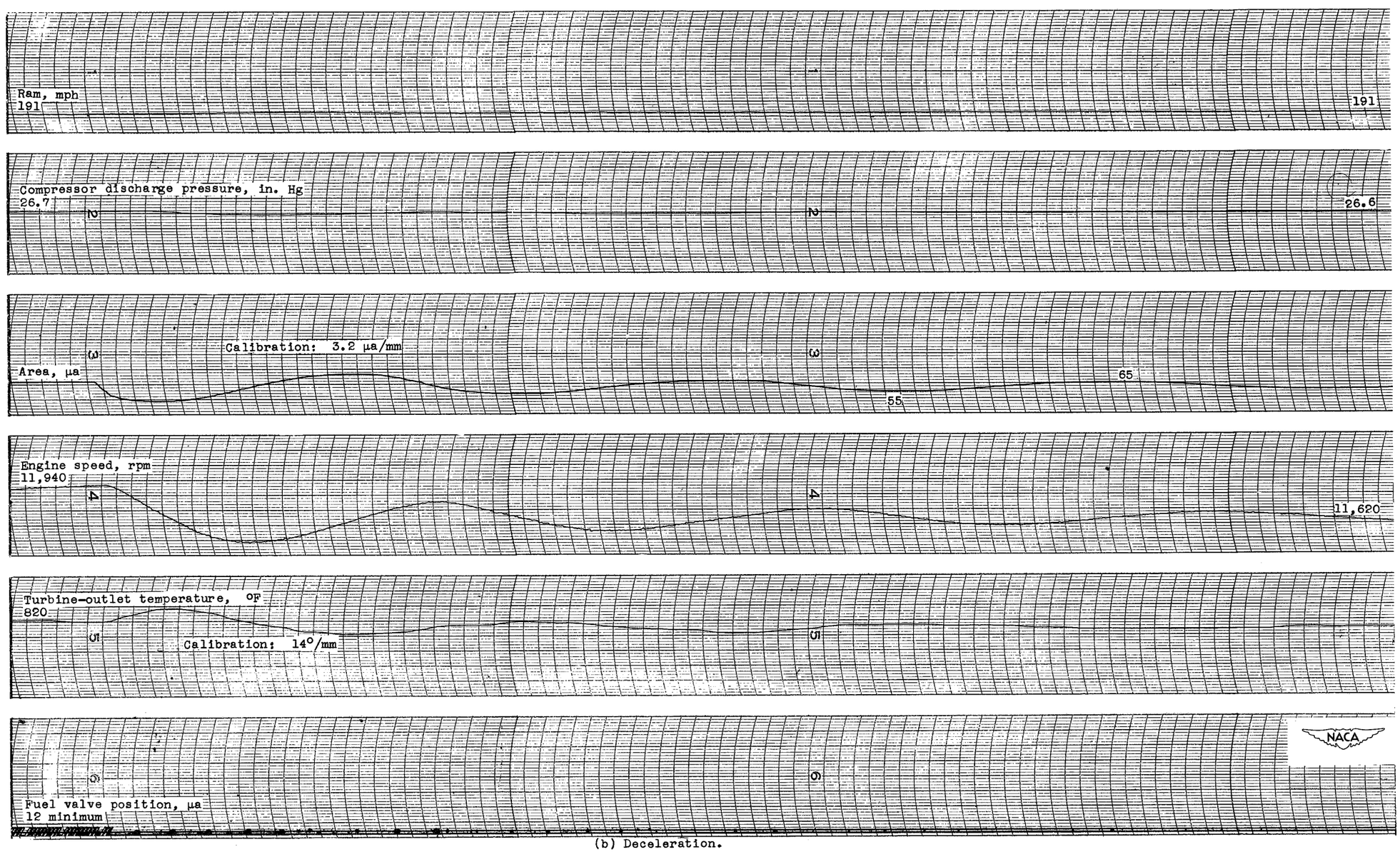
(a) Acceleration.

Figure 55. - Transient operation of automatically-controlled engine. Throttle position, 46.5° to 55°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



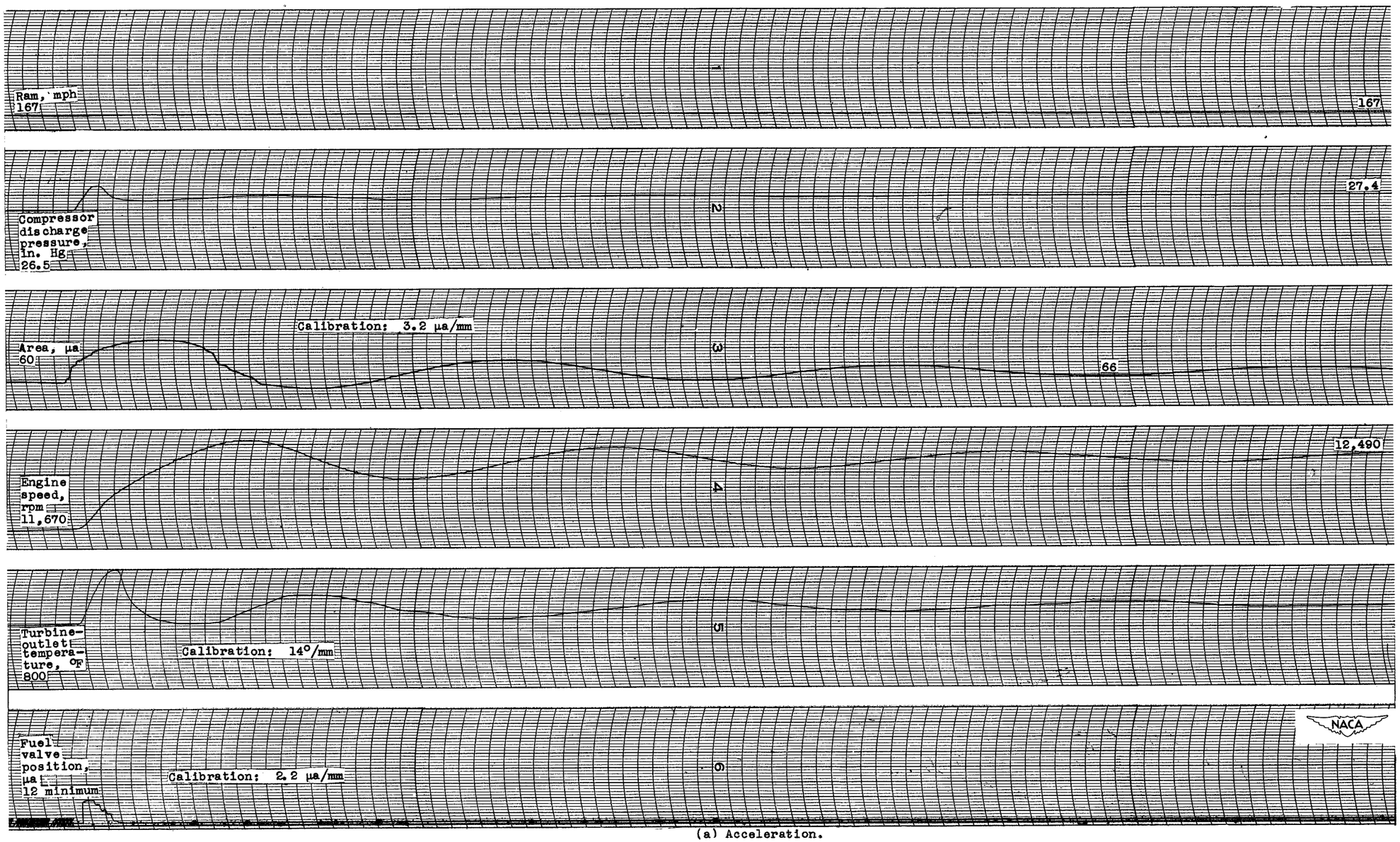
(a) Concluded. - Acceleration.

Figure 55. - Continued. Transient operation of automatically-controlled engine. Throttle position, 46.5° to 55°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



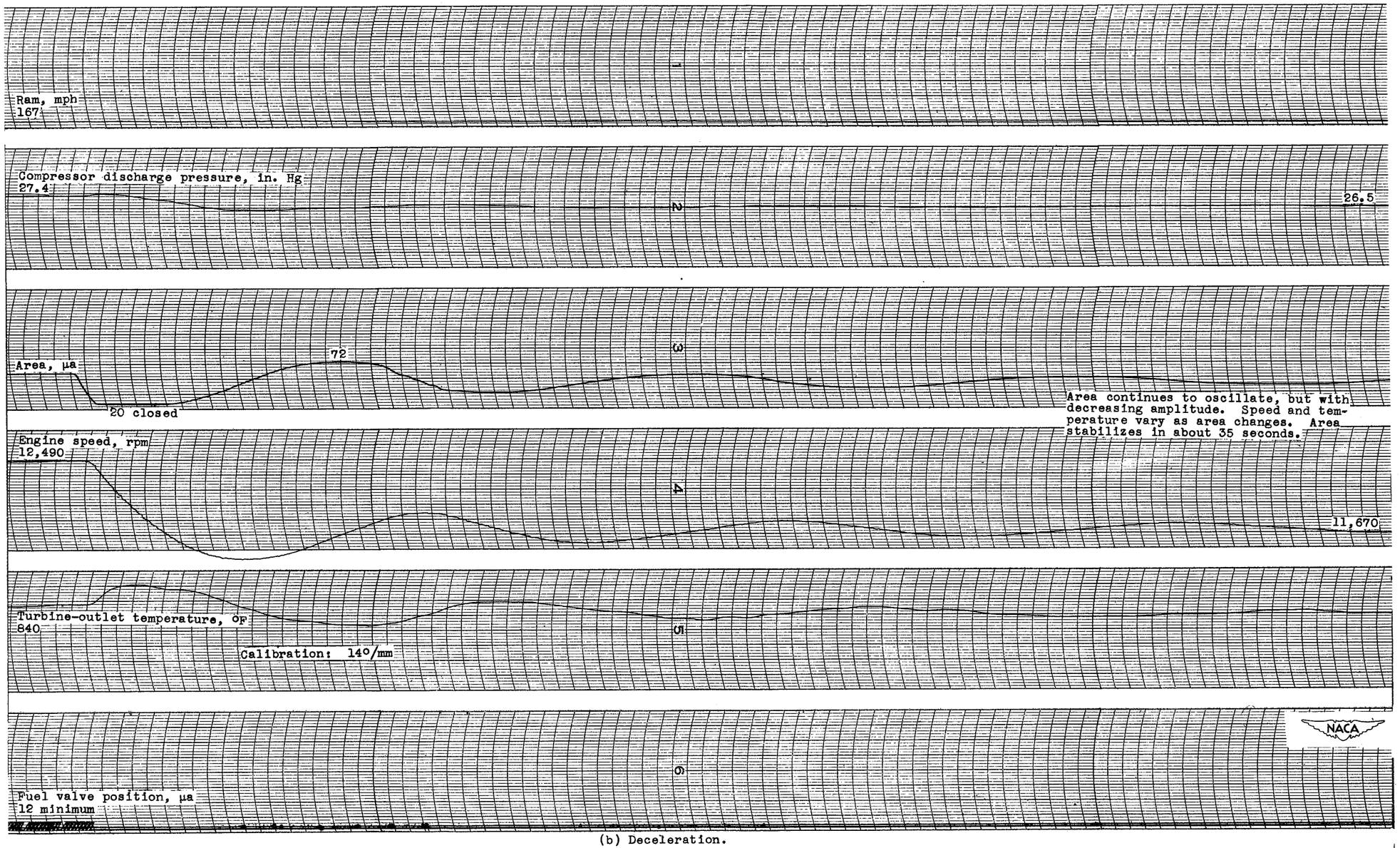
(b) Deceleration.

Figure 55. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 46.5° to 55°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



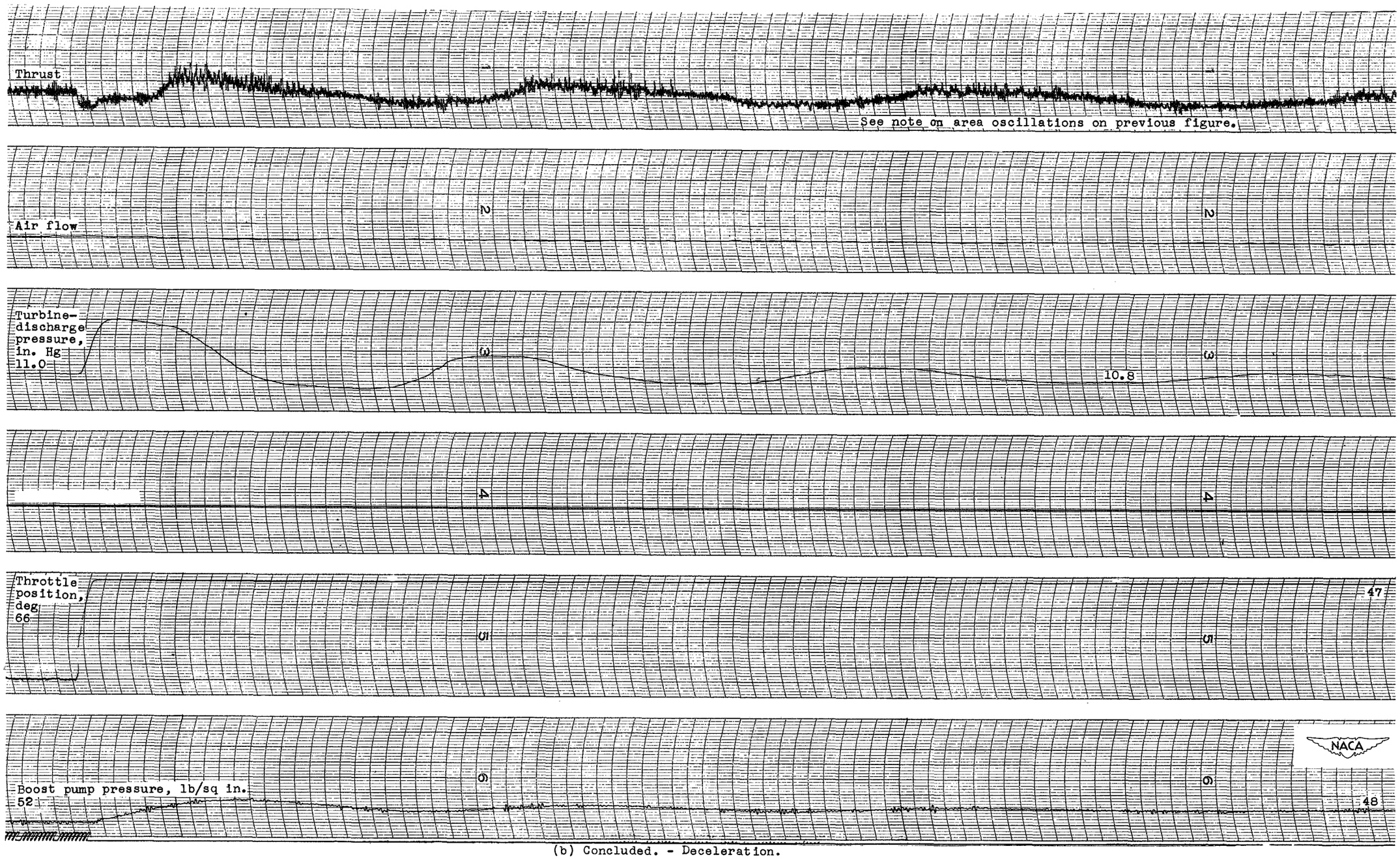
(a) Acceleration.

Figure 56.- Transient operation of automatically-controlled engine. Throttle position, 47° to 66°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



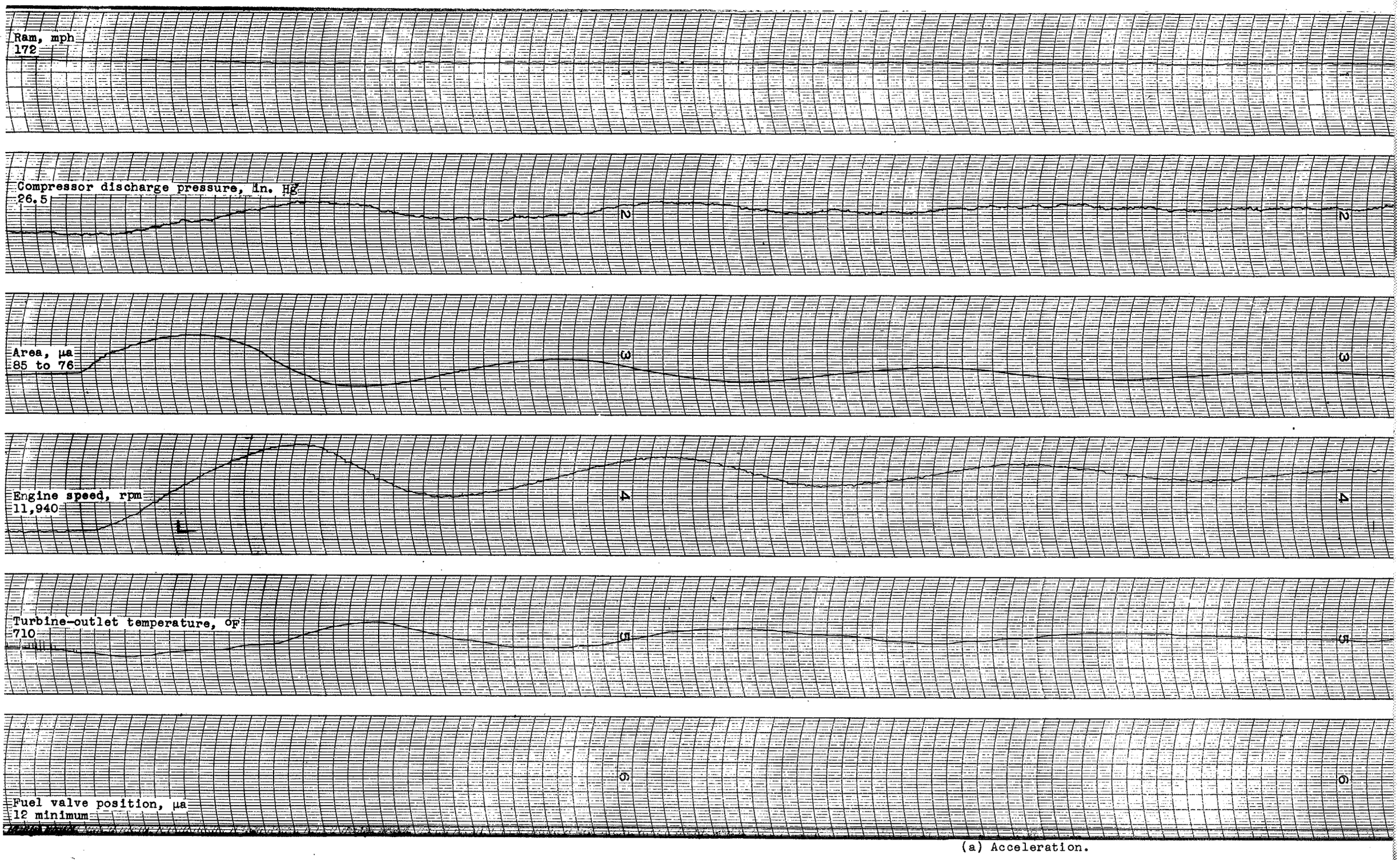
(b) Deceleration.

Figure 56. - Continued. Transient operation of automatically-controlled engine. Throttle position, 47° to 66°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



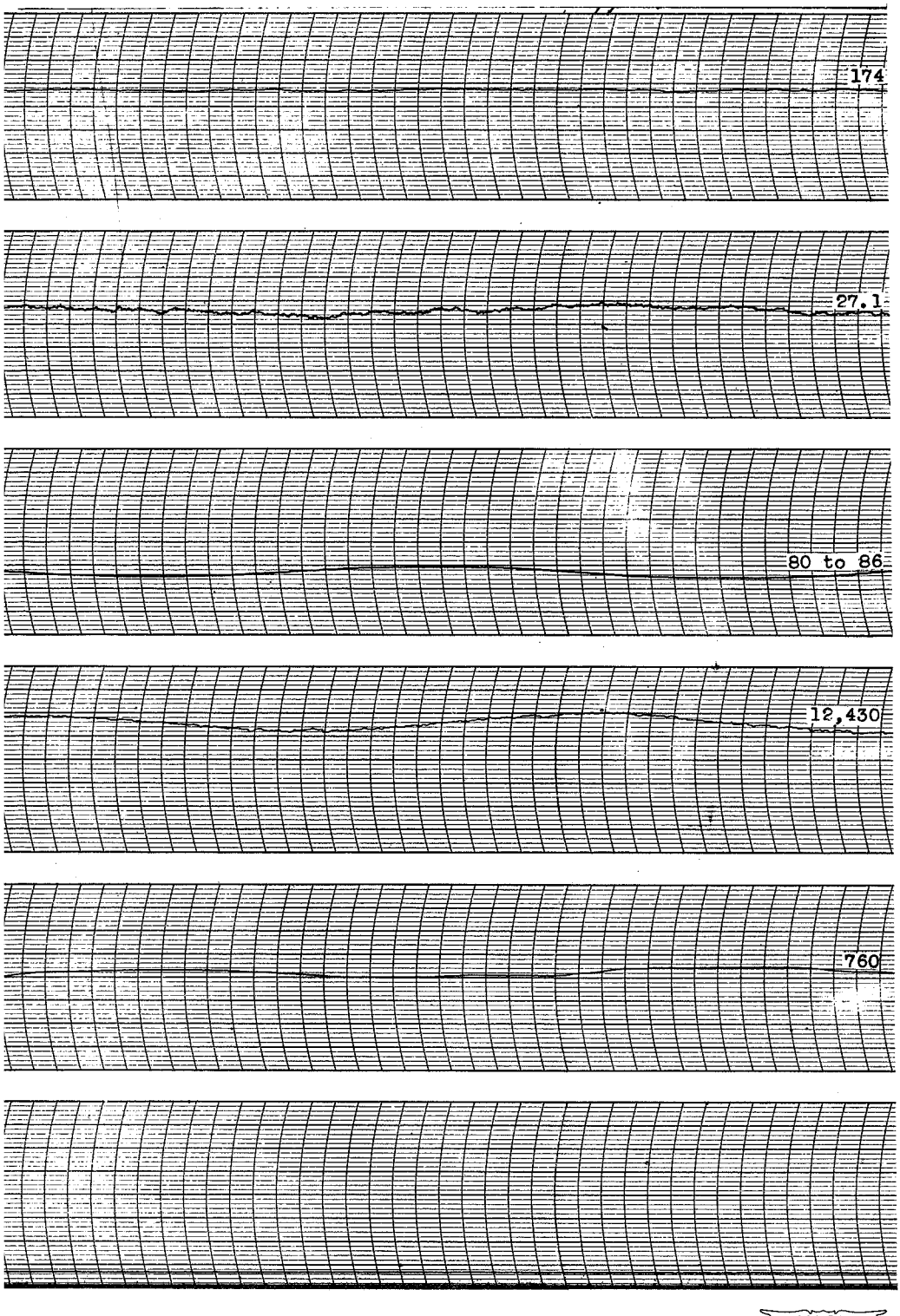
(b) Concluded. - Deceleration.

Figure 56. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 47° to 66°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.



(a) Acceleration.

Figure 57. Transient operation of automatically-controlled engine. Throttle position, 50° to 62°; altitude, 40,000 feet; nomi



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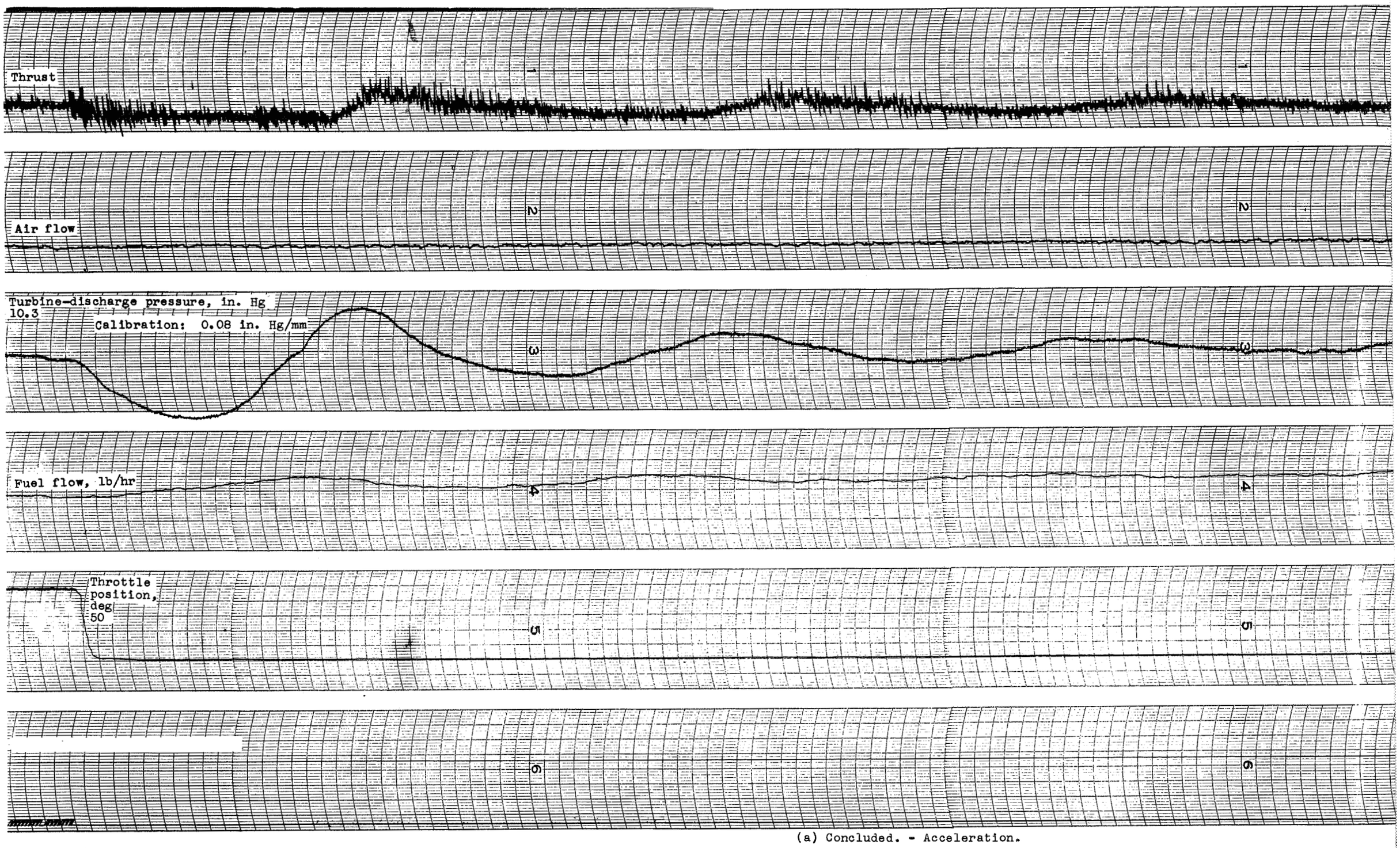
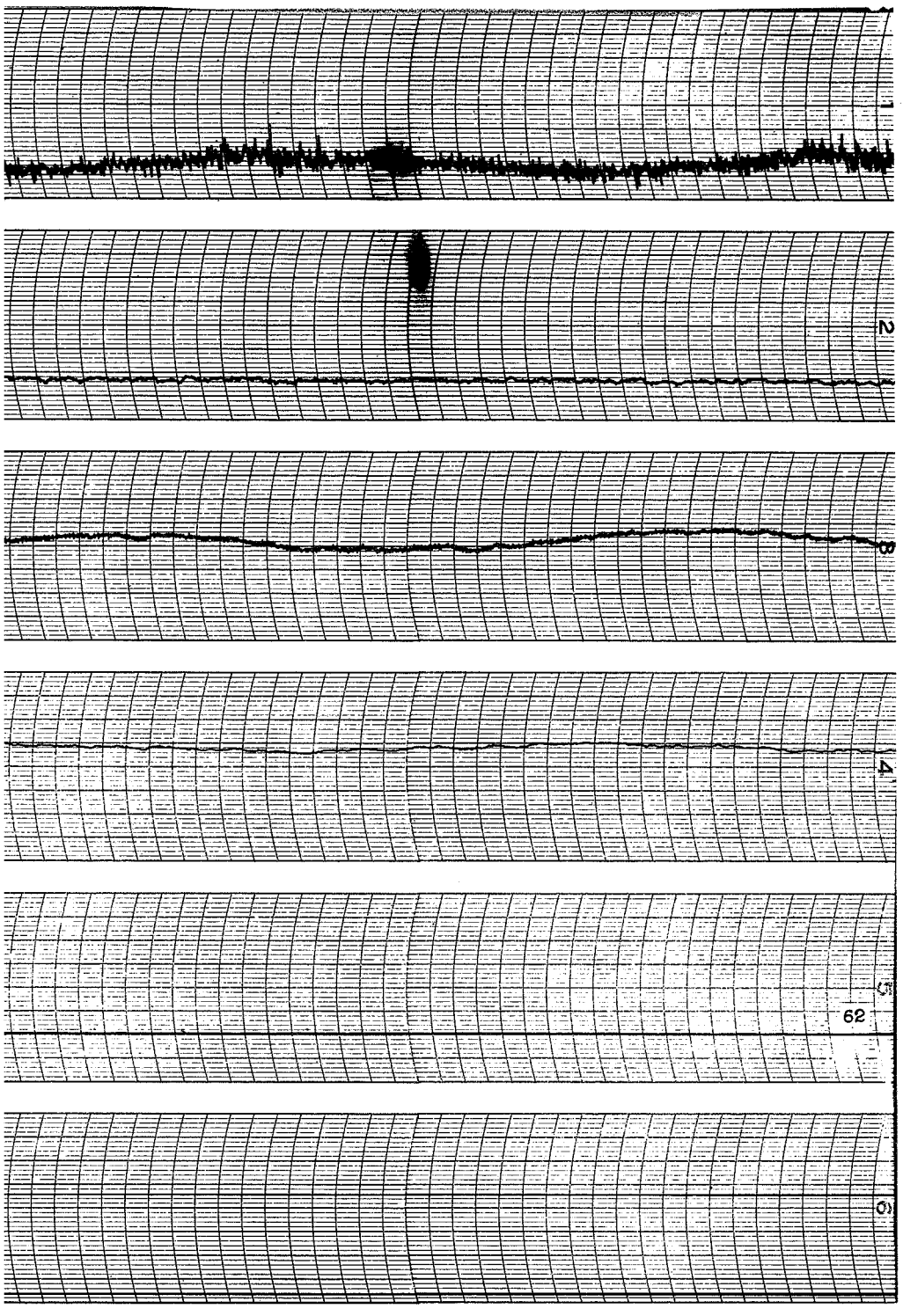
al ram-pressure ratio, 1.2.

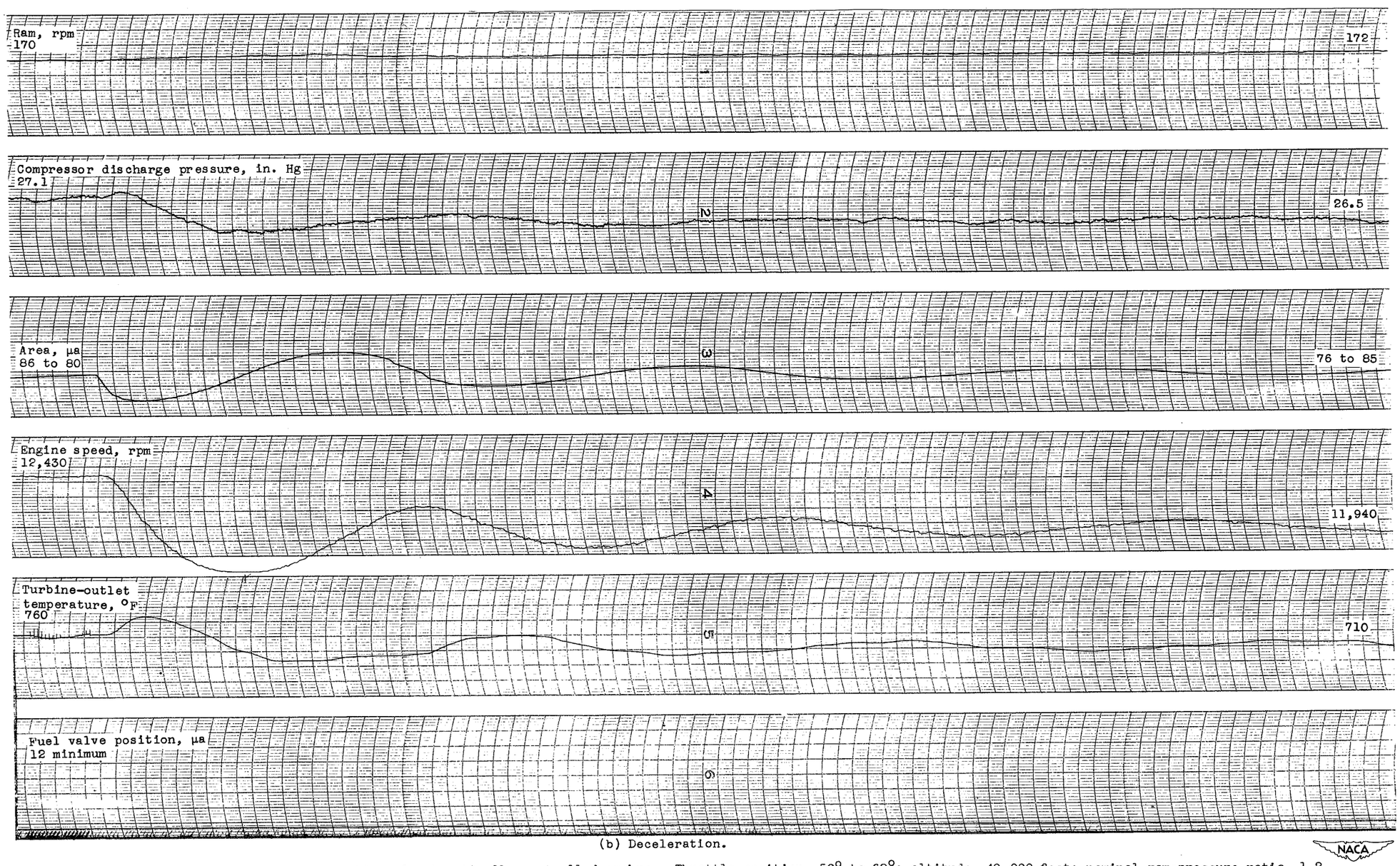


(a) Concluded. - Acceleration.

Figure 57. - Continued. Transient operation of automatically-controlled engine. Throttle position, 50° to 62°; altitude, 40,000 feet; nominal ra



r-pressure ratio, 1.2.



(b) Deceleration.

Figure 57. - Concluded. Transient operation of automatically-controlled engine. Throttle position, 50° to 62°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.

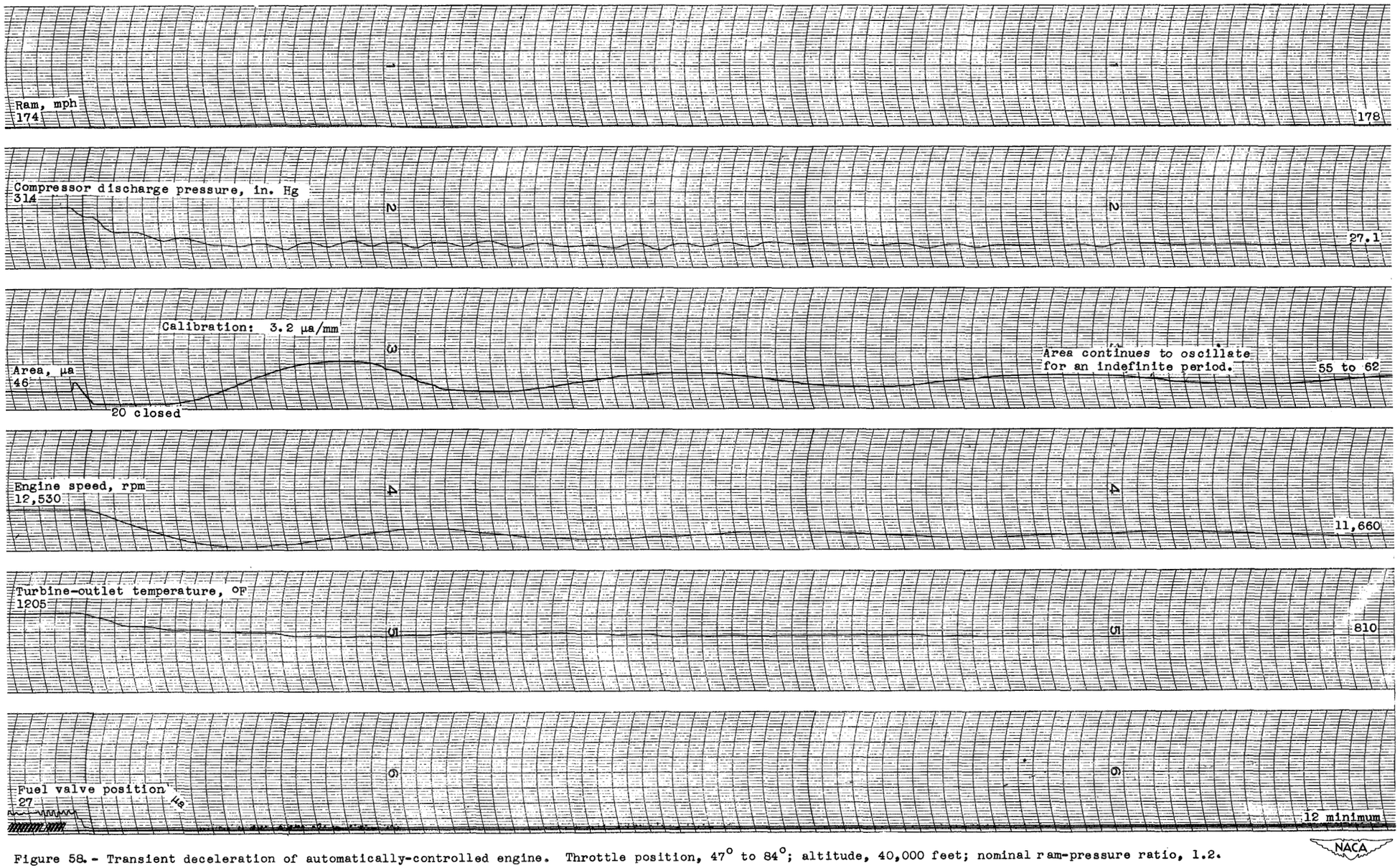


Figure 58.- Transient deceleration of automatically-controlled engine. Throttle position, 47° to 84°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.

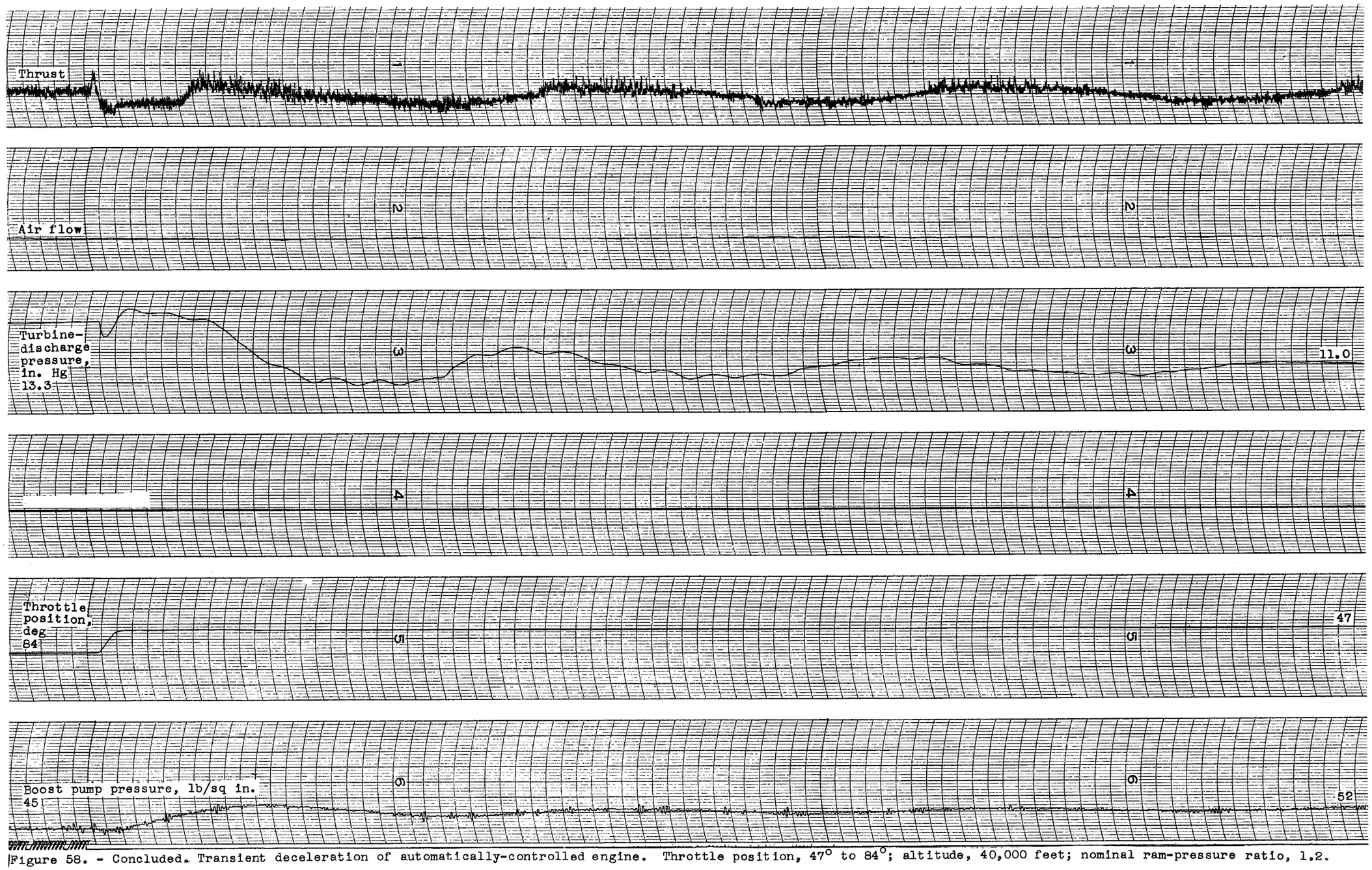


Figure 58. - Concluded. Transient deceleration of automatically-controlled engine. Throttle position, 47° to 84°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.

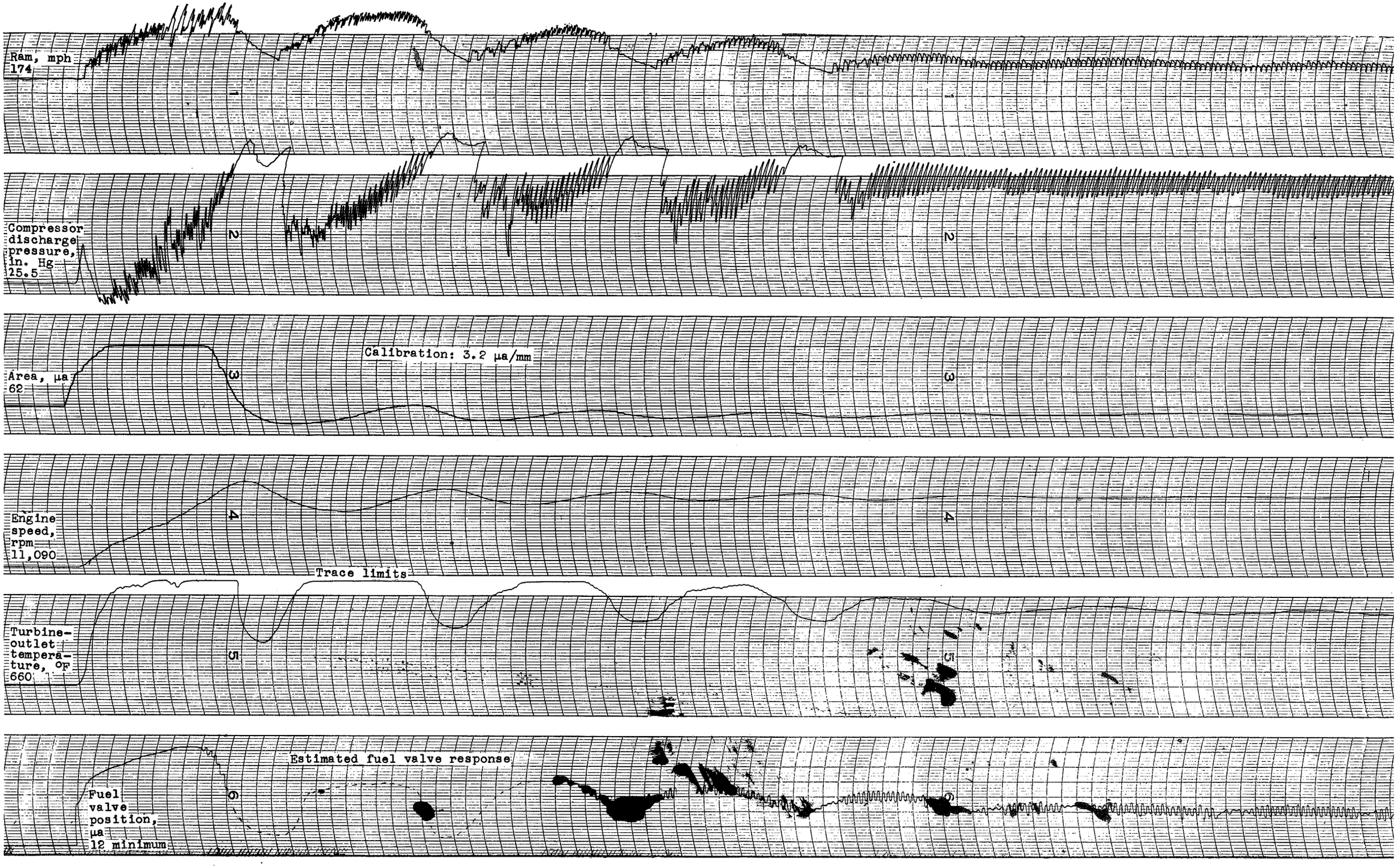
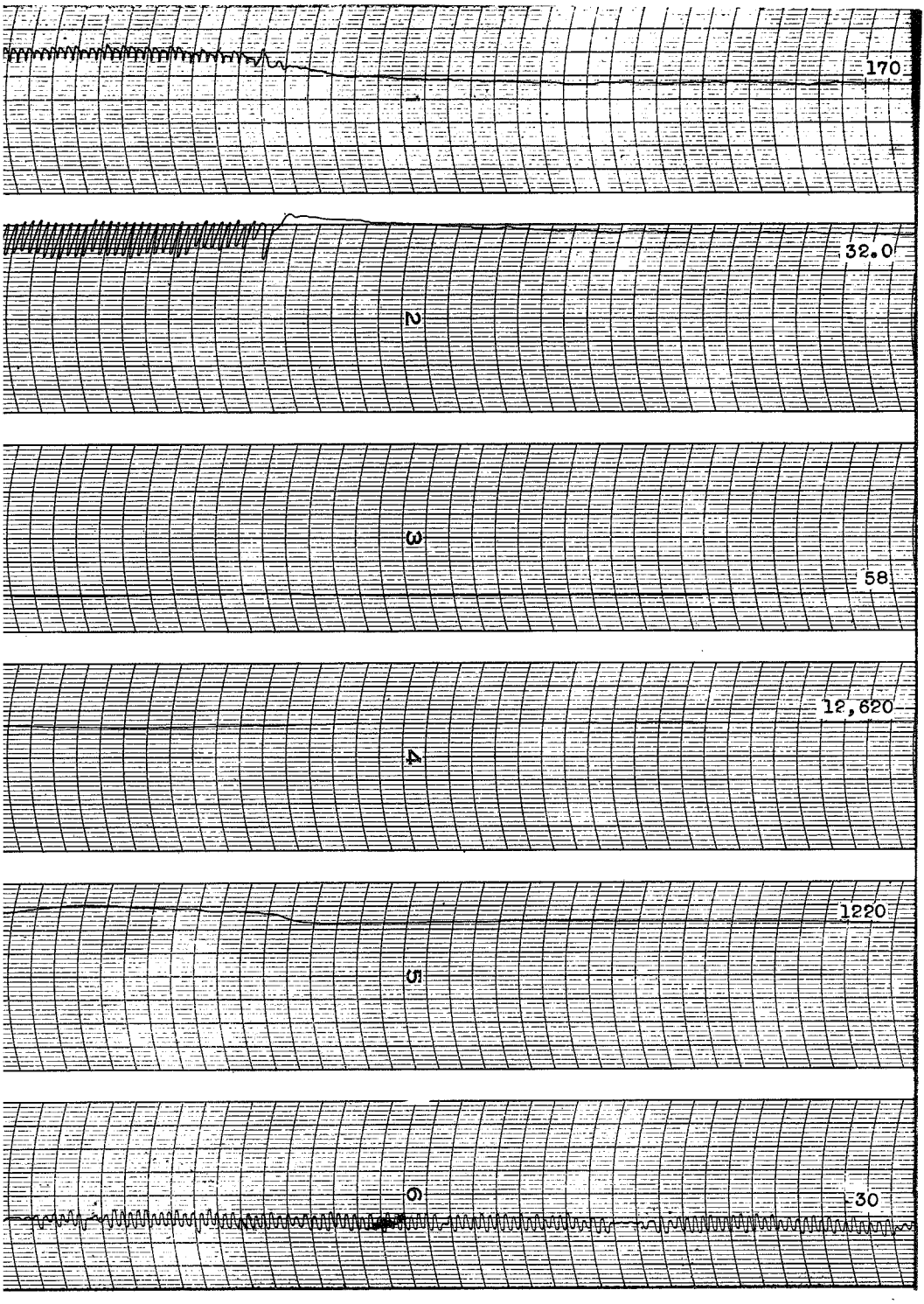


Figure 59. - Transient acceleration of automatically-controlled engine. Throttle position, 41° to 84°; altitude, 40,000 feet; nominal ram-pres



ure ratio, 1.2.

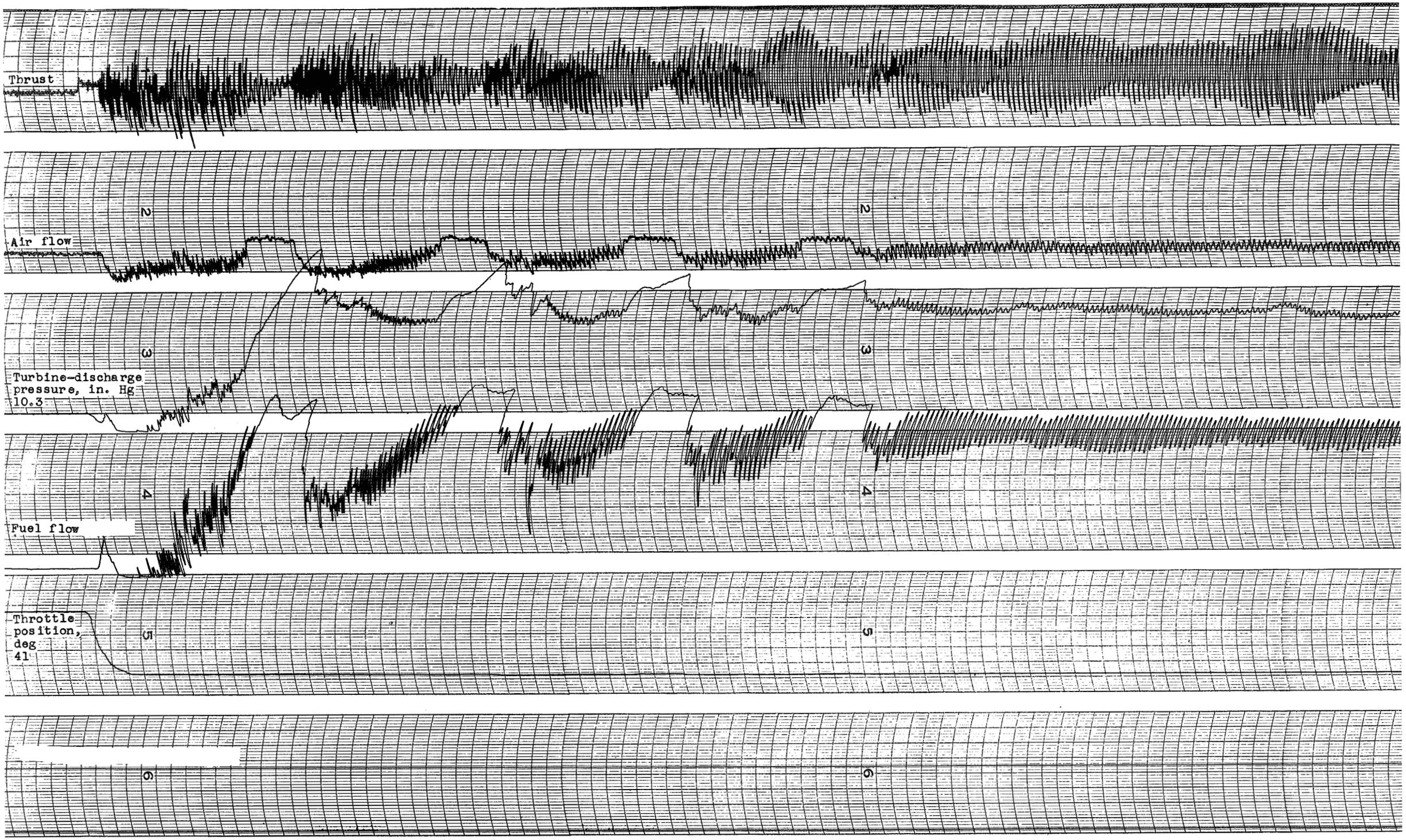
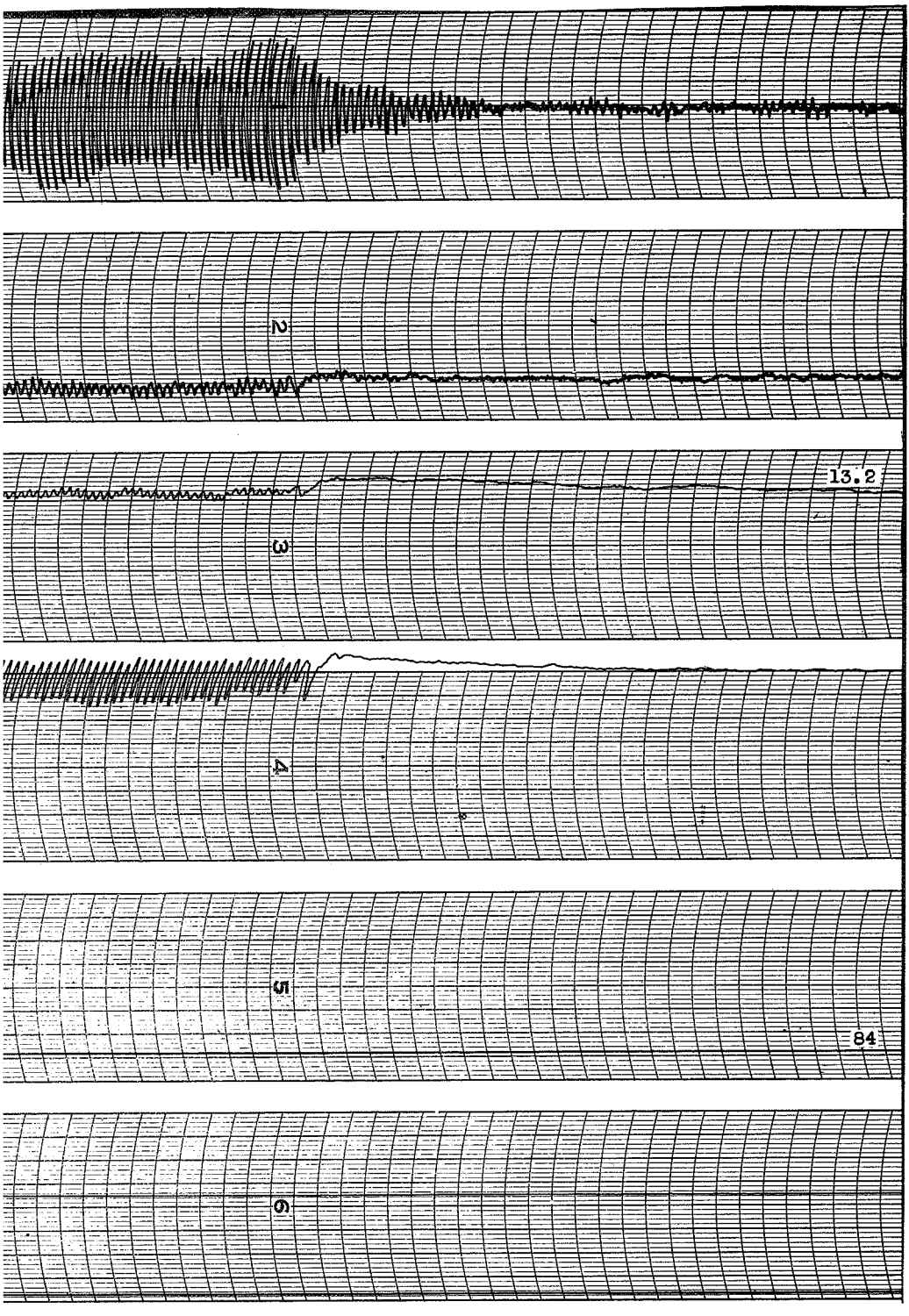


Figure 59. - Concluded. Transient acceleration of automatically-controlled engine. Throttle position, 41° to 84°; altitude, 40,000 feet; nomi



al ram-pressure 1.2.

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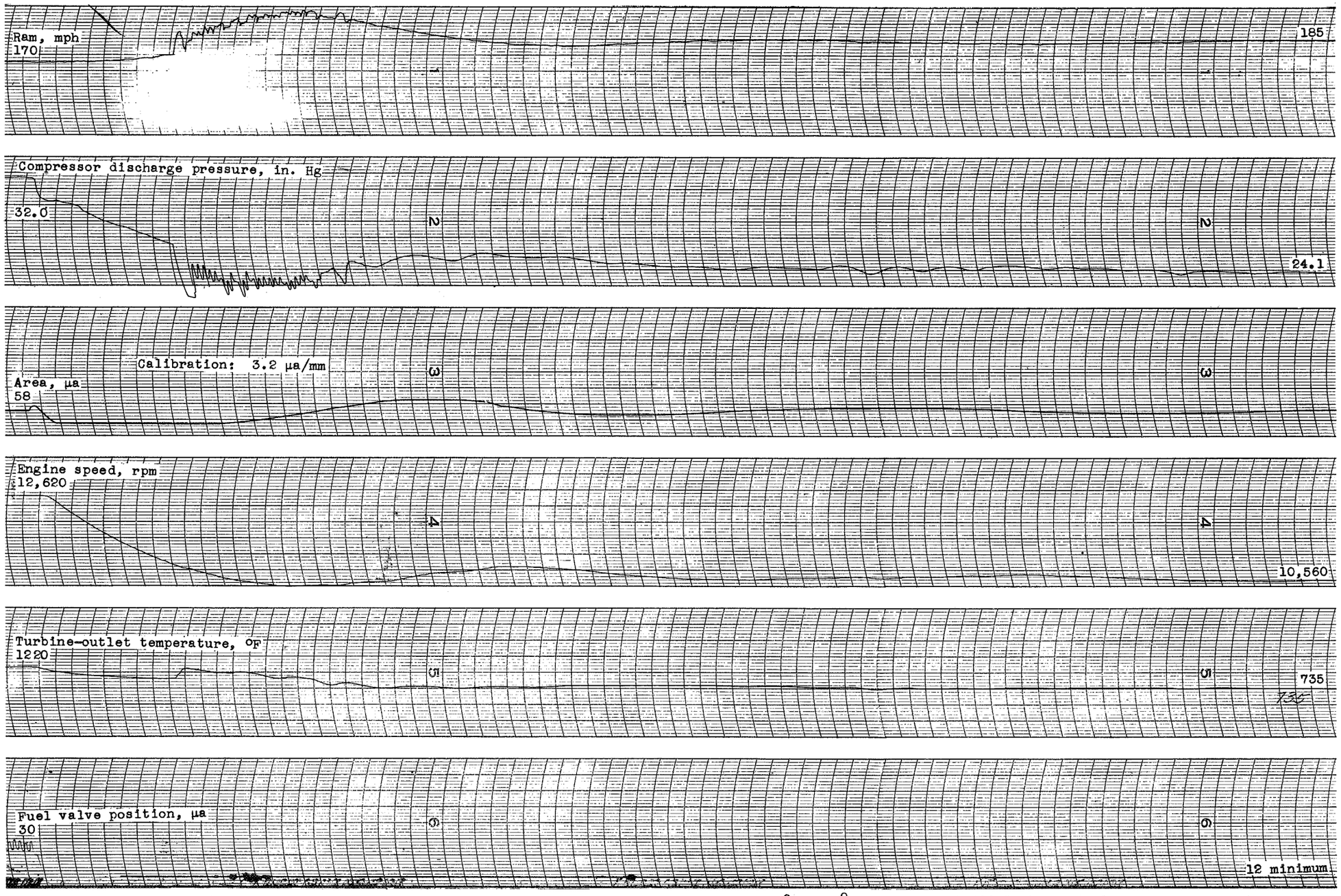

Figure 60. - Transient deceleration of automatically-controlled engine. Throttle position, 39° to 84°; altitude, 40,000 feet; nominal ram-pressure ratio, 1.2.

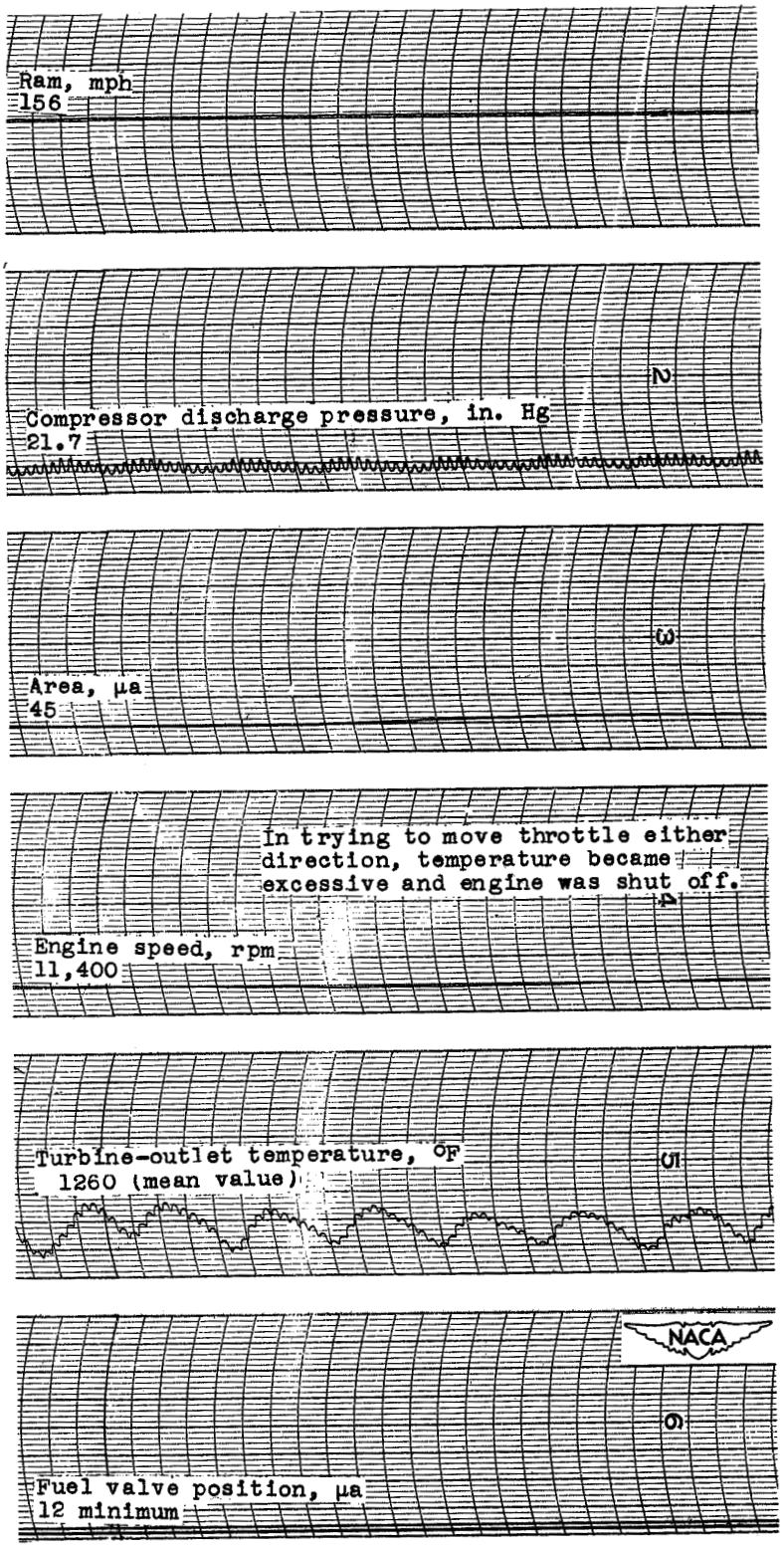

Figure 61. - Unstable steady-state operation of automatically-controlled engine. Throttle position, 47°; altitude, 45,000 feet; nominal ram pressure ratio, 1.2.

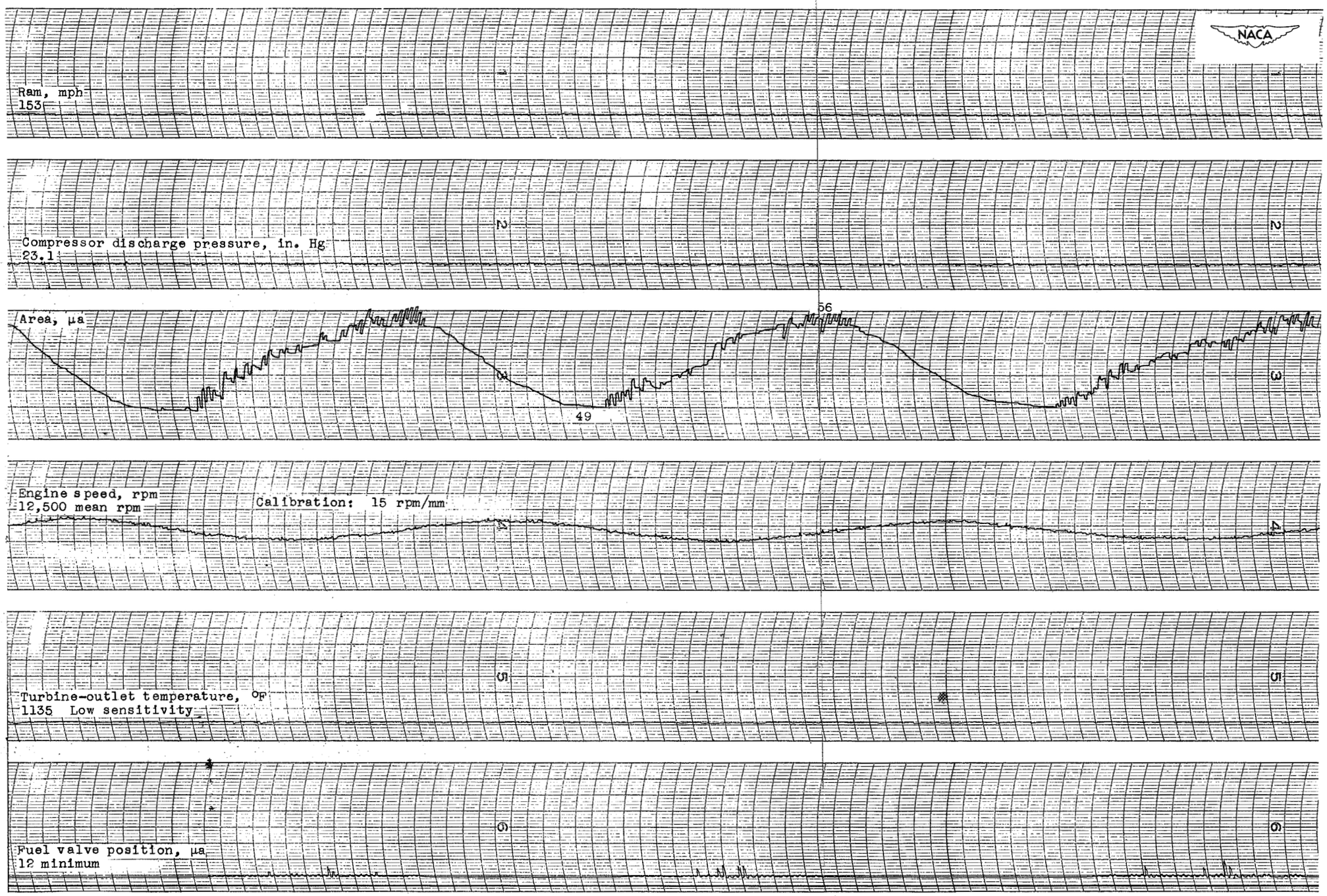

Figure 62. - Unstable steady-state operation of automatically-controlled engine. Throttle position, 80°; altitude, 45,000 feet; nominal ram pressure ratio, 1.2; engine inlet temperature, 47°F.

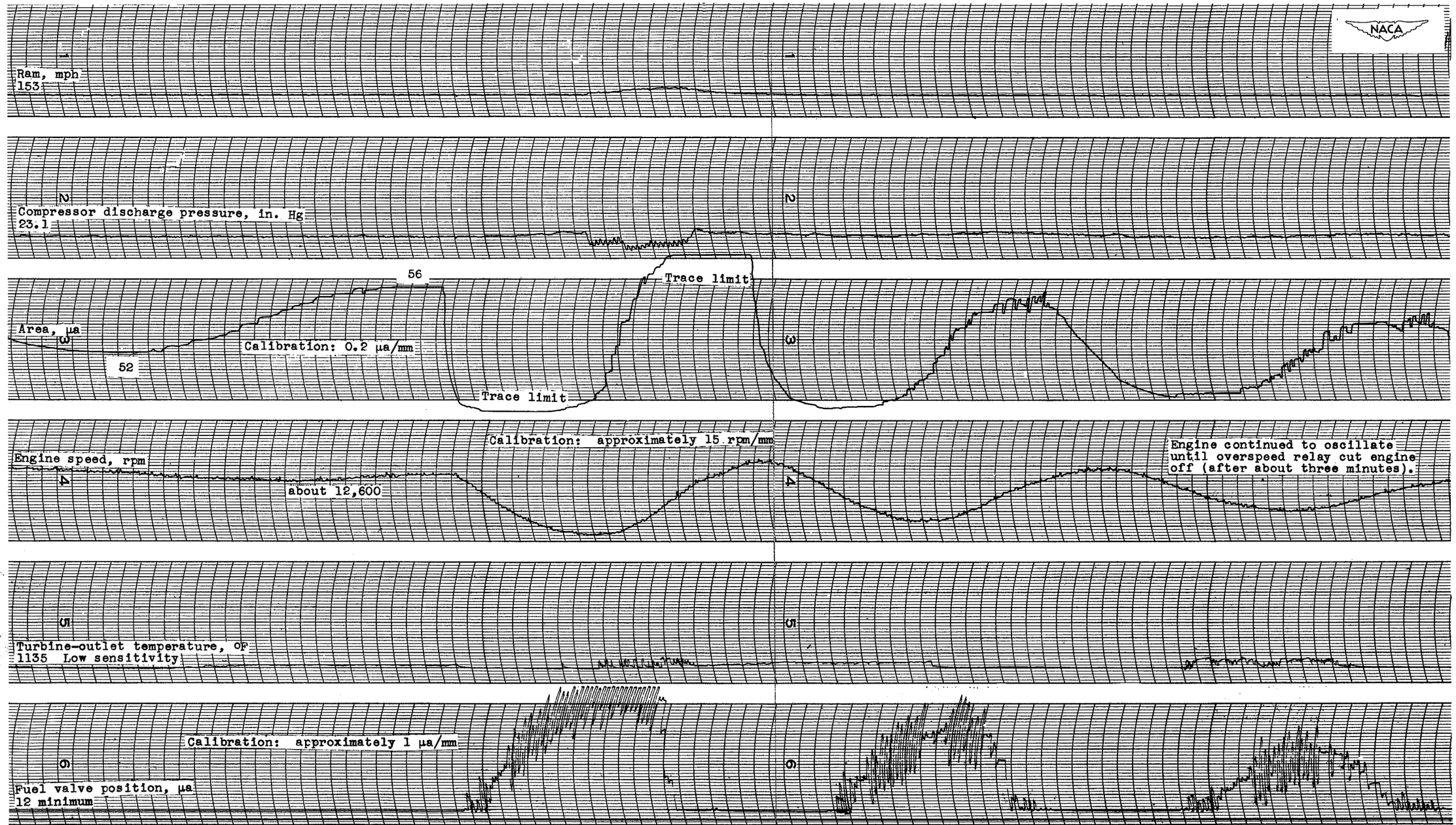

Figure 63. - Transient acceleration of automatically-controlled engine. Steady-state points unstable. Throttle position, 80° to 84°; altitude, 45,000 feet; nominal ram pressure ratio, 1.2; engine inlet temperature, 47°F.